B.C. Hydro

MOOSE STUDIES

REVELSTOKE PROJECT

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B. C. HYDRO

REVELSTOKE MOOSE STUDIES

R. M. BRADLEY

ENVIRONMENTAL SERVICES
SYSTEM OPERATIONS AND MAINTENANCE DIVISION

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JULY 1986

REVELSTOKE MOOSE STUDIES

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SECTION 1.0 - INTRODUCTION

1.1 HISTORY AND BACKGROUND

Prior to licence hearings for the Revelstoke hydroelectric project, B.C. Hydro engaged consultant services to assess the wildlife populations that might be affected (Paish 1974; Environmental Resource Consultants 1976; Entech 1975). As an outcome of the hearing a resident wildlife biologist was hired to continue the collection of data pertaining to the wildlife. This biologist, and the programmes initiated, were put in place in 1977 as a requirement of the Conditional Water License.

In May 1977, biologists from B.C. Hydro and from the provincial Fish and Wildlife Branch agreed upon a division of responsibilities for wildlife studies. B.C. Hydro would be responsible mainly for valley areas and wildlife species whereas the Branch was to concentrate on upland areas and species; both parties were to undertake studies dealing with moose. Studies were coordinated to maintain economic efficiency and the production of data agreed to by joint approval. The main objectives of these studies were twofold:

1. to inventory terrestrial wildlife, and

2. to assess project impact on these populations.

This report summarizes moose data collected from 14 March 1977 to 6 February 1985 by the project biologist, R. Bonar, and various assistants including summer students. In 1980, budget limitations precluded the continued use of assistants so a decision was made by the project biologist to use all the available time for data collection at the expense of compilation, analysis, and annual reporting. Therefore

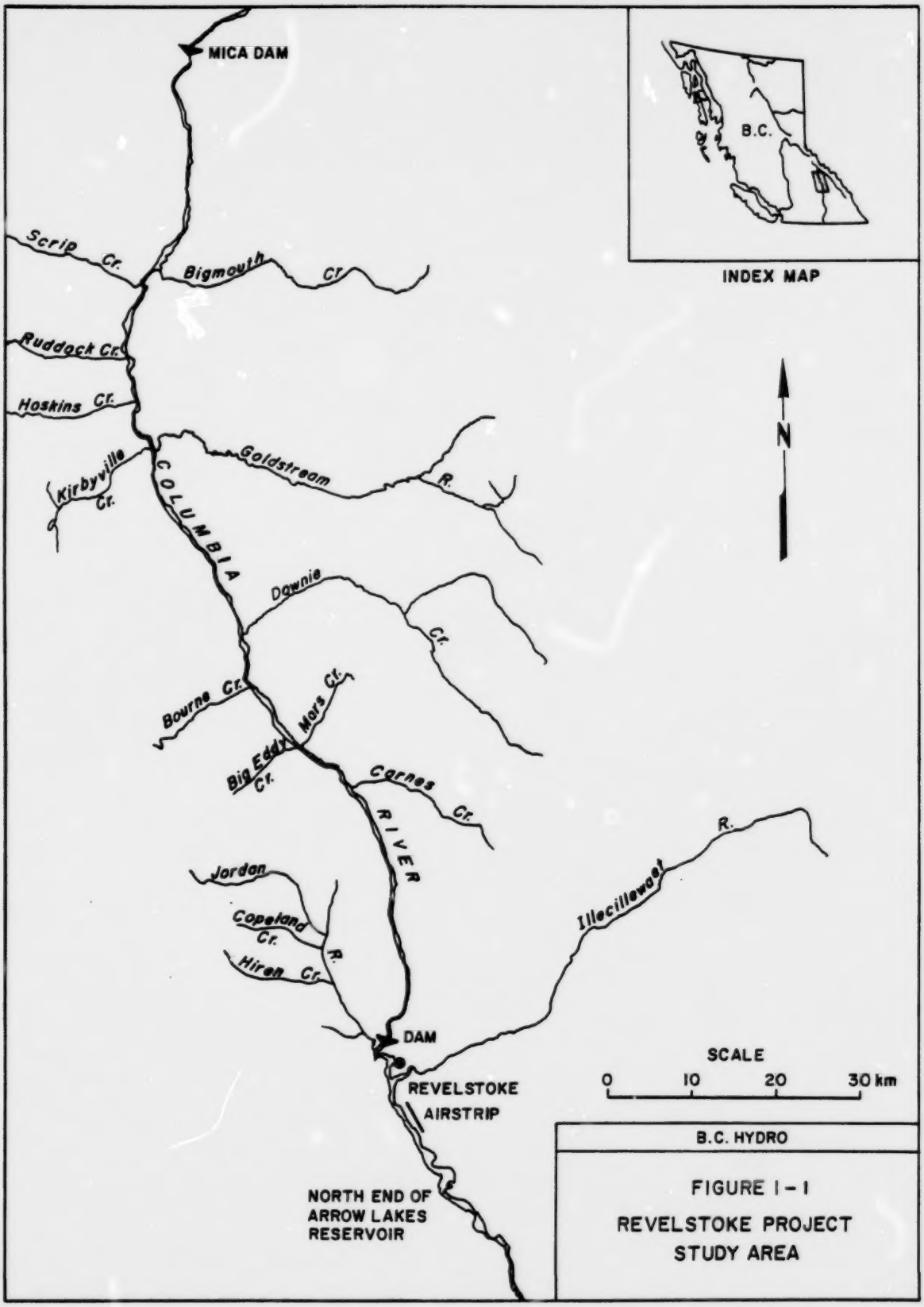
the data for most of 1979 and all of 1980 to 1985 are in raw field notes, on data collection forms, on maps or on aerial photograph mosaics. In March of 1985 the Revelstoke project staff were disbanded because construction activities were completed. At this point, the role of data compilation, analysis and write-up were transferred to the Environmental and Socio-economic Services Department.

Data assessments in this report are to be considered preliminary only, with a view to describing the type of data collected, the strengths and limitations of the data, where and how such data are stored, and the general significance of these data to project impacts. The latest annual report covering 1978 work (Bonar 1979) and a partially completed draft annual report prepared by R. Bonar later in 1979 were referred to for background information and methodology.

1.2 AREA DESCRIPTION

The study area was about 5400 km² and encompassed the Columbia River watershed between the City of Revelstoke and the Mica Dam in east-central British Columbia (Fig. 1-1). Most study programs were restricted to the mainstem Columbia River valley below the proposed reservoir level (573 m, 1880 ft). The valley is steep-sided with elevations ranging from 349 m at Revelstoke to 3076 m at Mt. Chapman. Orientation is north to south with mountain ranges bordering both sides, the Monashee Range to the west and the Selkirk Range to the east. Soils, bedrock, surficial geology of these ranges are described by Environmental Research Consultants (1976).

The area is within the "interior wet belt" climatic region (Krajina 1976) which is characterized by the wettest most productive forests in the Interior of B.C. A precipitation gradient exists from Revelstoke (105 cm) to Mica Creek (146 cm). The snow portion of this precipitation increases from 381 cm in the south to 737 cm in the north. A


MICA DAM
Scrip Cr.
Bigmouth Cr.
Ruddock Cr.
Hoskins Cr.
Kirbyville Cr.
COLUMBIA
Goldstream R.
Downie Cr.
Bourne Cr.
Mars Cr.
Big Eddy Cr.
Carnes Cr.
RIVER
Jordan
Copeland Cr.
Hiren Cr.
R.
Illecillewaet R.
DAM
REVELSTOKE AIRSTRIP
NORTH END OF ARROW LAKES RESERVOIR
B.C.
INDEX MAP
N
SCALE
0 10 20 30 km
B.C. HYDRO
FIGURE 1-1
REVELSTOKE PROJECT
STUDY AREA

temperature gradient also exists. Mean annual, maximum and minimum temperatures at Revelstoke are 7.2°C, 40.6°C and -34.4°C. The same variables for Mica record 4.2°C, 35.6°C and -37.2°C (Environment Canada 1971).

The vegetation in the valley has been classed into three biogeoclimatic zones (Krajina 1969). The vegetal characteristics of these zones, Interior Western Hemlock, Englemann Spruce- Subalpine Fir, and Alpine, are given by Environment Research Consultants (1976). Most of the valley is covered with mature coniferous forest with serial patches of logged and burned areas.

1.3 TIMING OF RESERVOIR CLEARING

The impact of the Revelstoke hydroelectric project on moose actually began with pre-logging of merchantable timber 1 year before reservoir clearing officially started in September 1977. The general pattern of clearing has been to work in a northerly direction from the damsite. A total of 8923.3 ha were cleared from 1977 to the end of 1983 (Table 1-1). Only a small portion (3.3 percent) was cleared in 1977 and activities accelerated to about 18 percent per year for 6 years thereafter. Final cleanup in 1983 was only 4.6% of total clearing. Maps showing chronological sequence of clearing could be compared to pre-clearing distribution of vegetation types, to habitat utilization patterns recorded for wildlife, and to vegetation remaining above the impoundment to get a comprehensive assessment of the impact of the clearing and impoundment. Computer analyses using B.C. Hydro's digital terrain map of the reservoir are possible given sufficient budget.

Following initial examination of the reservoir area in the spring of 1977, the resident biologist identified and mapped areas of particular importance to terrestrial wildlife within the reservoir perimeter. These areas were designated as wildlife habitat reservoir areas (HRA)

TABLE 1-1

RESERVOIR CLEARING* PROGRESS IN HECTARES

Treatment	1977	1978	1979	1980	1981	1982	1983
Cleared	297.7	1573.7	1696.0	1685.8	1614.2	1646.2	409.7
Total cleared	297.7	1871.4	3567.4	5253.2	6867.4	8513.6	8923.3
Percent cleared per annum	3.3	17.6	19.0	18.9	18.1	18.4	4.6

* Based on Nelson (1980) for clearing to 1979 and Ministry of Forests (1984) for subsequent clearing. All figures converted to metric.

for the purpose of distributing negative impacts on moose, beaver and waterfowl over a longer time period. These HRA's also delayed the impacts of clearing to some degree and hopefully facilitated adjustments by the wildlife to the changing environmental conditions.

Twelve HRA areas covering approximately 604 ha (Table 1-2) were preserved. All areas were flat riparian habitats which often incorporated wetland types used by the greatest number and variety of terrestrial wildlife species. Isolation of HRA's by clearing of surrounding areas had little apparent effect on the use of these areas by wildlife (Bonar, pers. comm.). For example, moose crossed large open spaces during winter to reach preferred winter habitats in the reserve areas.

Clearing of the HRA's occurred in 1982, leaving one winter with a totally cleared reservoir prior to the onset of filling in October 1983.

1.4 LAND UTILIZED FOR CONSTRUCTION

Aerial photography of the Revelstoke valley was done on 25 July 1976. At that time the only habitat disturbance at the dam construction site was the clearing of about 30 ha of access roads and drill sites. Project construction commenced in the summer of 1977. Aerial photography of 30 July 1979 showed construction disturbance of 392 ha including work areas, roads, borrow pits, offices and camp facilities. About 53 percent of this area had been covered in mature cedar-hemlock forest; the remainder had been previously logged.

TABLE 1-2

WILDLIFE HABITAT RESERVE AREAS IN RESERVOIR AREA

Reserve No.	Name	Location	Area (ha)
1	17 Mile Jordan	Riparian flat on right bank mile 17 Jordan Road	41.7
2	21 Mile Jordan	Riparian flat on right bank mile 21 Jordan Road	23.5
3	18 Mile	Riparian flat on left bank mile 18 Highway 23	15.5
4	20 Mile	Riparian flat on left bank mile 20 Highway 23	36.8
5	25 Mile	Riparian flat on left bank mile 26 Highway 23	12.5
6	Mars North	Riparian flat on left bank mile 27.5 Highway 23	17.6
7	3 Islands	Riparian flat on left bank mile 29.5 Highway 23	21.5
8	Park Creek	Riparian flat on right bank just north of Park Creek	17.6
9	32 Mile	Riparian flat on left bank mile 32 Highway 23	139.0
10	Seymour	Riparian flat on right bank just north of Seymour Creek	133.3
11	Downie	Riparian flat on right bank opposite mouth of Downie Creek	29.1
12	Horne Creek	Right bank and riparian flat and island at Horne Creek	115.6
		TOTAL	603.7

1.5 LAND UTILIZED FOR HIGHWAY 23 RELOCATION AND TRANSMISSION CONSTRUCTION

Portions of Highway 23 from Revelstoke to Mica Creek had to be relocated to elevations above the reservoir level. During 1979, 61 km of new road was contracted and 443 ha were cleared. New construction contracts in 1980 resulted in some additional clearing but actual figures are not available.

The transmission line associated with the Revelstoke project is a short link (10 km) south of Revelstoke which connects to the existing grid. There was no environmental input towards route selection or design although the resident biologist did do a superficial site examination to identify potential environmental problems. The total clearing for the line is approximately 167 ha. Prelogging started in the summer of 1979, extended through the winter, and was completed in 1980.

1.6 TIME OF PROJECT IMPACT

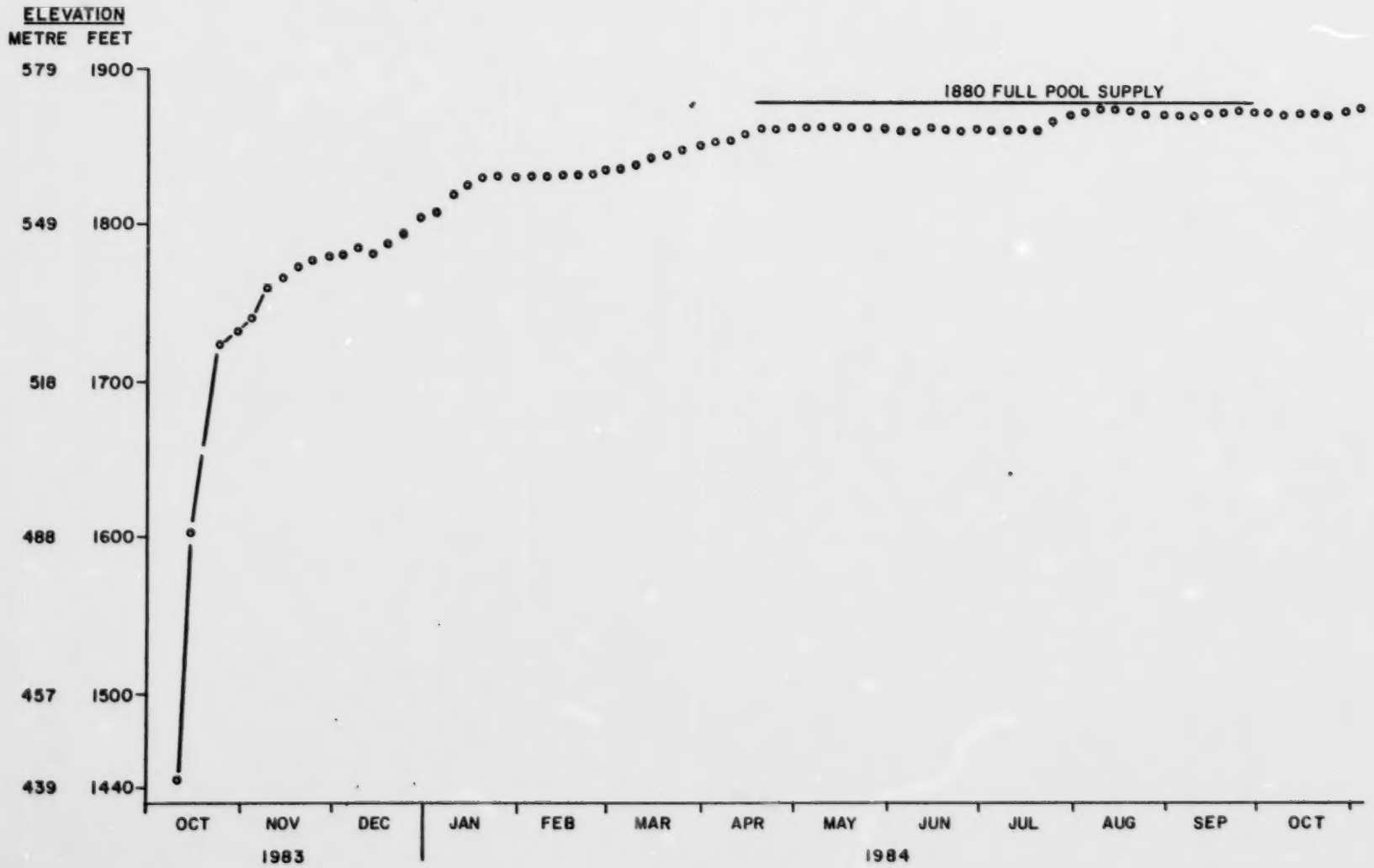
The nature of the progressive reservoir clearing followed by filling makes it difficult to set a time demarcating onset of project impact. The time lag of wildlife response to disturbances further confuses the analysis. Reservoir clearing in the form of low elevation logging actually began in anticipation of the project approval. In this sense, impact started to occur before the detailed project planning. However, in the absence of hydroelectric development, these patches would have eventually been logged. If the project had not proceeded, however, they would have provided early succession browse and would have provided a net improvement on the availability of ungulate food in the valley. As the reservoir clearing program progressed, the availability of seclusion cover and winter range declined. Areas critical to wildlife (604 ha) were identified as Habitat Reserve Areas so that clearing could be left until the last year before filling. As a result of this progressive change, I have somewhat arbitrarily selected the

commencement of filling (October 1983) as a basis for statistical comparisons of before and after impact. On 11 October 1983 the gates of the Revelstoke dam were closed with a river elevation of 440 m (1445 ft) above sea level (Fig. 1-2). Water rose during the next 2 weeks to about 533 m (1750 ft). This rapid inundation of bottom lands, even though these were already cleared and some had 6 years of regeneration, is taken as the specific time of impact. The full pool supply level of 573 m (1880 ft) was not reached until 5 November 1984.

1.7 ACKNOWLEDGEMENTS

My thanks to Mr. Rick Bonar who designed the study program and toiled to collect the data. I also appreciate the technical review given by Mr. J. Kelly.

FIGURE I-2 HISTORY OF RESERVOIR ELEVATION BY DATE



SECTION 2.0 - POPULATION INVENTORY AND DYNAMICS

2.1 METHODOLOGY

Although the second objective of the Revelstoke terrestrial studies was to "assess the impact of reservoir formation on moose populations" (Bonar 1979, p. 91), no specifically designed methodology was applied to achieve this objective. "Annual trend surveys" are mentioned as source data for assessment of impact on moose numbers and "moose inventory flights" by the Fish and Wildlife Branch are cited as source data for "classification of animals by sex and age" (Op. cit., p. 100).

Aerial flights in the period 1977 to 1980 were flown with the main objective being a winter population inventory. Later flights were usually carried out in conjunction with some other aspect of the moose study such as winter habitat utilization or tracking of radio-equipped animals. These aerial surveys were flown on the general basis of helicopter availability and shared use with geotechnical studies. In total 92 aerial flights using a Bell 206-B helicopter were taken over the 8 calendar years. The flights were not randomly distributed throughout the year (Table 2-1) and did not meet standard criteria for aerial survey techniques (Davis and Winstead, 1980). Flight paths were not preplanned or mapped. Flights did not occur during or near the calving peak in June. Strong emphasis was placed on the winter of 1983/84 when radio-collared moose were being tracked. Marking of moose also included some visible collars and some distinctive markings (tattered ears, scars on face, etc.). A circle or low slow pass were made over moose seen to identify sex, age, and group size. Serious attempts were made to determine the sex of every adult moose but some portion of the population always evaded these efforts. Several factors influenced the observer's ability to get sex and age information of all animals. When a large group was spotted, an overall count was made and

TABLE 2-1

TEMPORAL DISTRIBUTION OF AERIAL SURVEYS FLIGHTS

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Winter Surveys
1977													0	2
1978	1		1									1	3	2
1979		1											1	3
1980	2	1										1	4	7
1981		1	5									1	7	11
1982	8		2										10	7
1983	2	3	2									8	15	53
1984	12	10	12	11							4	1	50	7
1985	1	1											2	
TOTAL	26	17	22	11							4	12	92	92

then the helicopter was brought in close to obtain more detailed data. Some animals managed to disappear or lodge themselves in dense vegetation during this closer observation. Even in small groups some animals escape to dense cover and resist all attempts to move them into the open again. During the spring, bulls had no antlers and sexual differentiation from an aircraft became more difficult. The presence of antlers or pedicels in conjunction with the absence of the white vulval patch (Mitchell 1970, Roussel 1975) were used to distinguish males. Even in spite of these efforts, some animals which refused to budge from bedding sites or continuously turned to face the helicopter had to be recorded as unclassified. Small body size and grayish pelage were used to distinguish yearlings from adults.

Aerial data were supplemented by ground observations throughout the year. All moose observations were coded into standard 80-column computer forms along with other wildlife sightings. Variables recorded include species, sex, age class, mark identification, vegetation type being used, group size, group composition, snow depth, elevation, and antler status (Appendix A.1).

Population estimates were derived by applying the Lincoln-Peterson Index (Seber 1973) to the most thorough survey for each month. Average annual, average-before-inundation, and average-after-inundation populations were then estimated. Sex ratios, age class ratios, calf production and survival, habitat occupancy and snow depths utilized were also assessed from these data.

2.2 DATA STORAGE

Aerial and ground survey observations are stored on the B.C. Hydro computer system under the file name: X.XX.FR1.AERIAL(MOOSE). The variable names and storage format are shown in Appendix A.1. In total there are 7380 lines of data, of which about 5525 record moose data.

2.3 ANALYSES DONE

(a) Population Estimation

The moose surveys done by helicopter do not readily lend themselves to standard population estimation techniques because they do not meet standard assumptions for sampling procedures. The primary objectives were to record habitat utilization or to relocate collared or radio-equipped animals, so areas of last-sighting are more heavily surveyed. Radio-equipped animals are over-represented in the surveys. Survey flights did not consistently cover all of the study area. Use of the radio equipment to locate an animal obviously negates normal sampling theory for population estimation so where possible these animals are excluded from consideration as animals observed and marks observed. Without specific data as to which collared animals were found by radio location, I have had to assume all relocations were by visual. The error in this assumption will cause an underestimate of the population. Marked animals were considered present only for sample periods prior to and including their last recorded observation. This assumption would also cause a population underestimate when "marked" animals were still alive but had not been seen for some time. The mark ratio in the population varied as new collars were placed over a 3-year period and as known mortalities were observed (Appendix C). Consequently the estimate of marks available had to be adjusted for each sample flight.

Several animals marked by the Fish and Wildlife Branch with coloured combinations of neck collars and ear tags could also have been considered as marked animals. Unfortunately these animals were not evenly distributed throughout the survey area and no mortality information was available to trace the progressive

attrition of marks available. This additional data source was therefore not used.

As a result of these study inconsistencies, I have applied a broad-brush approach to population estimation and to assessments of population trends. Population estimates based on all marked animals are generated for survey flights chosen as representative (Table 2-2). No corrections were made for sightability (Gasaway et al. 1985) because this factor is presumed to be reflected in the proportion of marked animals oberved. The population (N) at the time of each sample flight is related to the number of marks available (M) in the population in the same ratio as the sample count (n) is related to the number of marks reobserved (m). These periodic population estimates were then combined to derive an average moose population for each winter, a pre-impoundment population estimate (N_1) of 163 and a post-impoundment estimate (N_2) of 117. The confidence limits at 95 percent level (Bailey, 1951) were calculated from:

$$S.E. = \left[\frac{M^2 n\ (n - m)}{m^3}\right]^{1/2}$$

The pre- to post-impoundment change, compared by

$$t = \frac{N_1 - N_2}{\left[S.E._1^2 + S.E._2^2\right]^{1/2}} = \frac{162.8 - 116.9}{\left[71.42^2 + 34.05^2\right]^{1/2}} = 0.58$$

is not significant ($t < t_{.05} = 1.96$)

The variations between samples and between years are high. Repetitive samples taken within short time periods demonstrate that the precision of estimates is low. Comparison of populations before and after impoundment is intricately related to the precision of the respective population estimates. The detection of small differences is only possible with precise, i.e. repeatably accurate estimates. If the population has changed

TABLE 2-2

POPULATION ESTIMATES BASED ON VISUAL "RECAPTURES" OF MARKED MOOSE

Winter	Survey Date	Moose Seen (n)	Marks Seen (m)	Marks Available (M)	Population Estimate (N)	Average Winter Population
78/79	79/02/07	54	1	2	108	108
79/80	80/01/18	62	2	5	155	140
	80/02/21	50	2	5	125	
80/81	80/12/11	54	2	6	192	
	81/02/02	31	1	6	186	149
	81/03/09	27	4	10	68	
81/82	81/12/15	55	3	14	257	
	81/01/18	107	7	19	290	223
	81/01/23	46	5	21	193	
	81/03/02	102	17	25	150	
82/83	83/01/06	62	5	23	285	
	83/02/10	75	10	22	165	197
	83/03/01	25	3	17	142	
83/84	83/12/12	34	3	17	193	
	84/01/03	45	6	18	135	
	84/01/16	44	9	21	103	111
	84/02/10	30	10	20	60	
	84/03/16	43	13	20	66	
84/85	84/11/14	119	12	16	159	
	84/12/04	61	12	17	86	128
	85/01/15	92	13	16	113	
	85/02/06	124	12	15	155	

Average Population Estimate	153.9
Average Population Pre-impoundment (83/10/10)	178.2
Average Population Post-impoundment*	118.9

* The pre- and post-impoundment means are not significantly different

$F_{(12,8)} = 1.48 < F.05 = 4.20$

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greatly, then an estimate of low precision is all that is needed to detect the difference. The estimates made by the sampling procedures applied are not precise enough to conclude that the population has declined.

The bias caused by not knowing which animals were located by radio tracking is a serious problem and can be demonstrated by a detailed consideration of one of the more thorough surveys, a post-impoundment flight. On 6 February 1985 a fairly random and complete survey was done. On this flight ten radio-marked animals were known to be alive and eight of these were relocated in the 124 moose observed. Two marked animals were found by radio tracking whereas the other six were located visually. With the two radio-located animals erroneously included in the survey results a biased population estimate is:

$$N = \frac{Mn}{m} = \frac{10 \times 124}{8} = 125$$

Correction for the non-visual relocation of two moose results in:

$$N \text{ (corrected)} = \frac{10 \times 122}{6} = 203$$

This corrected value of 203 represents the best estimate of the post-impoundment moose population. The 95 percent fiducial limits of this population estimate (Davis, 1982) are two standard errors above and below this estimate, i.e. between 44 and 362. Therefore the true moose population should be between 126 (observed plus known marks not seen) and 362 (the upper fiducial limit).

At project outset, Environmental Research Consultants (1976) estimated that the moose population was 96 in 1968, 228 in 1970 and 202 in 1976. Therefore if population change has resulted from the project, the study methods used have not been precise enough to measure the change.

Converting the population estimate of 203 to a density figure so that comparisons to other North American moose populations can be made is a tricky calculation. There is no adequate means of identifying the area of the moose range. If a density is calculated on the exaggerated basis that the whole basin area of 5400 km² was moose habitat, then an unrealistically low estimate of 0.04 moose per km² is derived. If one were to ridiculously assume that all the moose depended upon the 115 km² below the 573 m (1880 ft) flood-line, a density of 1.8 moose per km² results. Therefore, the true density lies between these extremes. Most of the moose in the Revelstoke valley wintered below the 914 m (3000 ft) elevation, an elevation which subtended 800 km² of valley bottom. The density of this winter habitat would be 0.25 moose per km² for the preproject scenario.

Loss of the land below the 573 m reservoir level has concentrated the remaining moose onto a still smaller winter habitat. If all moose were to stay within the band from floodline to 914 m, the density would be 0.30 moose per km².

For comparison purposes, the density of moose in the Peace Region of B.C. is reported to be 0.6/km² (B.C. Ministry of Environment 1981). Eastman (1974) felt that moose in the sub-boreal spruce zone of B.C. occurred in "average densities approaching one/sq.mile" (0.4 per km²). The density (1973 to 1979) on the Kenai National Moose Range in Alaska has hovered around 3 to 4 moose per km² (Franzmann et al. 1980, Oldemeyer et al. 1977) so Revelstoke densities are not at the high end of the scale.

On a floodplain-type winter range in Jackson, Wyoming, Harry (1957) and Houston (1968) report densities up to 19.5 moose per km². Mercer and Manuel (1974), in Newfoundland, related density to measurements of vegetation productivity and found that high, medium and low habitat ratings supported 1.5, 0.8 and 0.15 moose

per km² respectively. However, the bulk of the literature report densities of similar magnitude or lower than that which assumes all Revelstoke moose below the 914 m (3000 ft) elevation. Telfer (1965) recorded an average of 0.6/km² in Nova Scotia; Penner (1976) found 0.96/km² in Peace River Alberta; Brassard et al. (1974) recorded a high density in Quebec of 0.3/km²; Krefting (1974) in Minnesota observed 1.1/km² in choice aspen/parkland habitat down to 0.1/km² in boreal forest; Karns et al. (1974) relate densities of 0.1 to 0.4/km² in Maine and 0.1 to 1.4 in Minnesota; Lykke (1974) reports 0.8/km² for Norway and Sweden; and the density in northeast Siberia is reported at 0.02 to 0.1/km² (Kistchinski 1974).

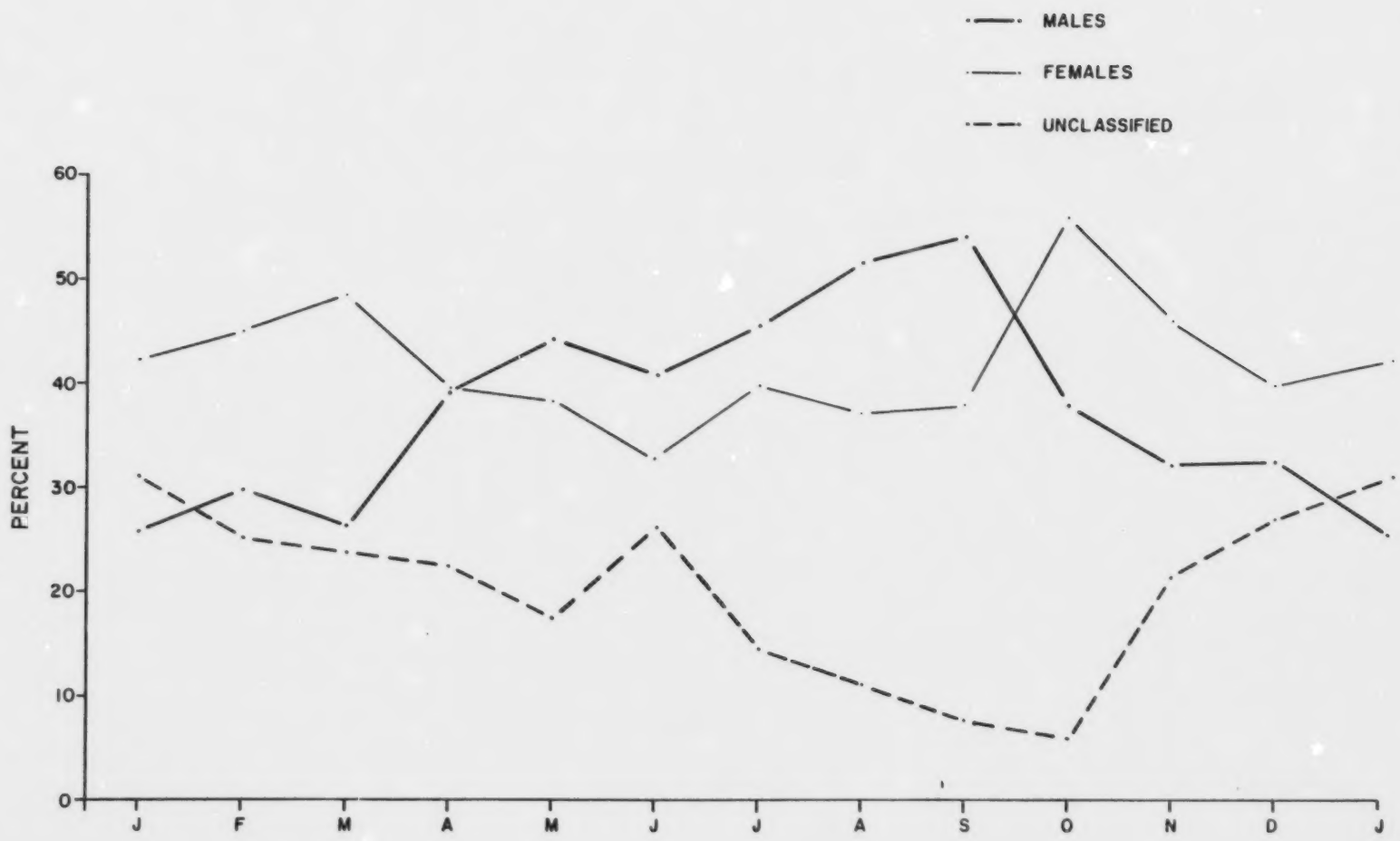
(b) Sex Structure

The Revelstoke observations record three categories of sex - male, female and unclassified (U/C).

The sex ratio does not remain constant throughout the year (Fig. 2-1). One influence on these proportions comes from changes attributable to the unclassified component. An obvious jump in U/C occurs in June during the calving peak. Corresponding dips are evident in both the male and female portions. As the young bull cohort develops antlers, they become recognizable as bulls and are removed from the unclassified segment. This change may explain the part of the regular decline in U/C animals as the year progresses. From April to September there appears to be an inverse correlation between U/C and males, whereas, no appreciable change in the female segment corresponds. Juvenile mortality would also be contributing to the decline in U/C during this period.

Several other factors including hunting, habitat use and antler changes are expected to influence the sex composition of the

FIGURE 2-1 SEX RATIO BY MONTH (ALL MOOSE OBSERVED AND ALL YEARS)



population. These are best demonstrated by removing the influences associated with juvenile mortality and population recruitment. Sex ratios for adult moose (Fig. 2-2) show some obvious changes from sex composition for all moose. The proportion of adults unclassified reaches a peak of 9.8 percent in January with a subsiduary peak of 6.5 percent in April. These two peaks may be contributing to a bias in the adult sex ratio based on the presence or absence of visible antlers. The proportion of moose identified as adult male is low in January to March (Fig. 2-3a), a period which coincides with the time bulls have no antlers (Fig. 2-3b). Antlerless males are more likely to be erroneously classified as females during this period from January to May. This error would contribute to the observed inflated proportion of females and the depressed value for males in this time period (Figs. 2-2 and 2-3a). The proportion of adult moose placed in the U/C category during the antlerless period is significantly larger ($P < 0.001$, than the number so classed when antlers are present.

However, at least one other factor must also play an important role in causing the differential sex ratio because the drop in males occurs in September/October when 100 percent of the adult males bear antlers. The hunting season in the Revelstoke Valley is limited to bulls over 2 1/2 years and extends from 10 September to 31 October. Therefore, hunting probably accounts for the sudden switch from predominately males (140 males:100 females) to a majority of females (61:100) which occurs from the September samples to the October ones.

The yearling moose should provide insight into the effect of harvest on sex ratio since hunting regulations protect this age class. Theoretically therefore, both sexes should be almost equally represented in the yearling class. The data collected do not support this supposition (Table 2-3).

FIGURE 2-2 SEX RATIO OF ADULT MOOSE

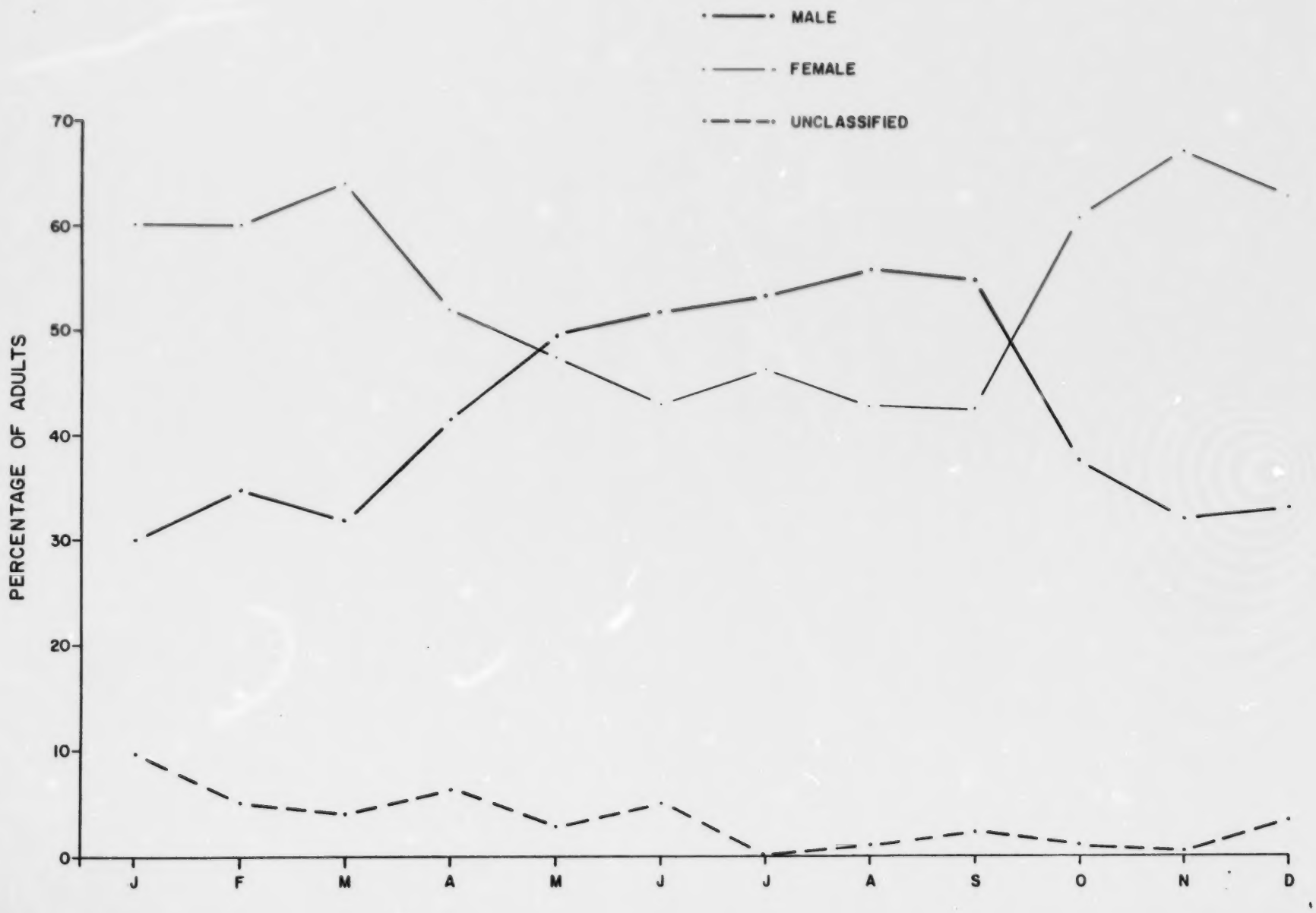
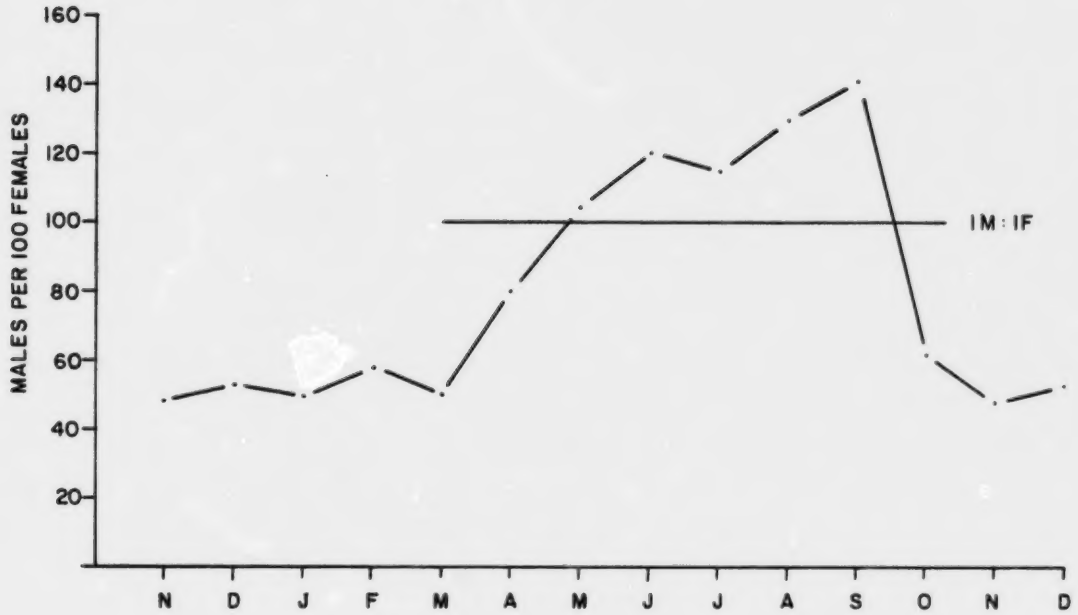


FIGURE 2-3 ANNUAL CHANGES IN ADULT SEX RATIO AS RELATED TO ANTLER-BEARING MALES



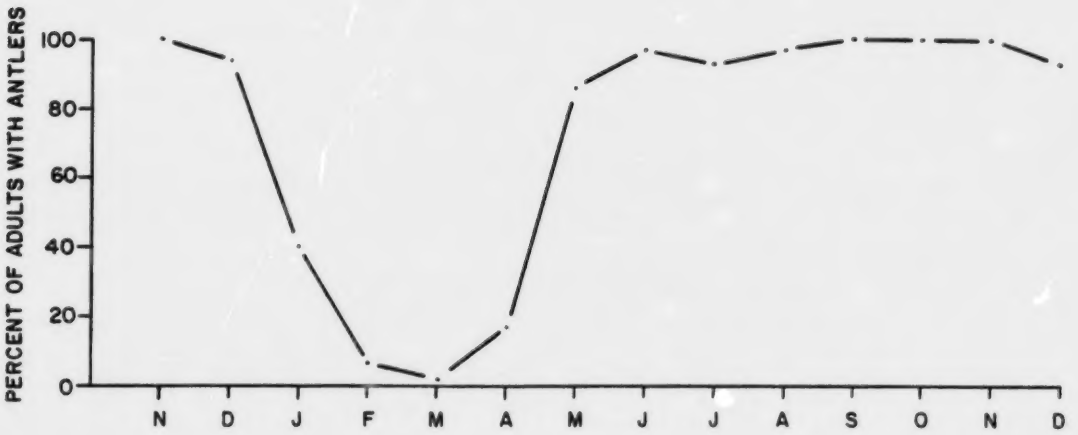


TABLE 2-3
SEX RATIO OF YEARLING MOOSE BY MONTH

	Month												
Sex	J	F	M	A	M	J	J	A	S	O	N	D	Total
Male	62	19	16	0	1	0	3	3	0	2	48	69	223
Female	9	6	8	0	1	0	2	0	0	0	1	3	30

Males outnumber females by almost 8 to 1. If this difference were all caused by the visibility of antlers on the yearling bulls, then the difference should disappear in February and March when antlers have dropped. Such is not the case although the ratio does become closer (2.5 males per female). Female yearlings are probably being classed as adult unless they are seen with a cow. This misclassification is easily understood when single animals are observed (25 percent of all moose and 48.6 percent of all groups) because there is no adult as a comparative size standard. Therefore, the sex ratio of yearlings must be considered as inappropriate for any analysis of seasonal changes, hunting-induced sex ratio shifts, or project impacts.

The chi-square contingency test was used to see if there were any signficant differences in bull/cow ratios between years. Using observations for all months of all years (Table 2-4), there is a highly significant difference at the 99.9 percent level ($X^2 = 103$, d.f. = 8). Each year was, therefore, tested against all other years combined to see which years contributed to this difference. From 1979 to 1982, males were under-represented in the sample ($P < 0.001$). Animals seen in the first 3 months of 1985 were proportional to the long-term average sex ratio.

TABLE 2-4

SEX RATIO OBSERVATIONS FOR ADULTS ONLY FOR ALL MONTHS OF ALL YEARS AND STATISTICAL SIGNIFICANCE OF EACH YEAR VERSES ALL OTHERS

Year	♂	♀	X^2	Significance
1977	20	26	0.6	N.S.
1978	50	84	0.0	N.S.
1979	33	117	17.2	<0.001
1980	66	196	20.0	<0.001
1981	34	93	7.1	<0.01
1982	110	286	20.1	<0.001
1983	114	234	4.6	<0.05
1984	784	947	76.9	<0.001
1985	101	151	0.5	N.S.
TOTAL	1312	2134		

This observed change in sex ratio could conceivably be a project-related event but is certainly not a readily explained one. Sampling methods are most suspect, as approximately 50 percent of all observations occur in 1984. Flight transects were not randomly selected but concentrated on areas of previous sightings with the specific emphasis on relocation of collared animals. In addition, observations were not evenly spread throughout the months or the seasons since approximately 60 percent of all observations occurred in winter months (November to April). Analysis by year of winter months only produced a similar contingency analysis but fewer years were individually significant. In the winter of 1981/82, males were under-represented in the sample ($X^2 = 10.1$, $P < 0.01$) and in 1983/84 they were over-represented ($X^2 = 17.2$, $P < 0.001$). In all other winters, the sex ratio did not differ from the combined years. All sex ratio data for pre-impoundment were significantly different ($X^2 = 21.8$, $P < 0.001$) from all observations after impoundment.

The observations of collared animals were examined to see if they provided any insight into the cause of this sex ratio change. If a sex ratio change is evident in collared animals then the observed change is obviously a function of the sampling as the sex ratio of animals wearing collars changed only slightly as new collars were added or old collars disappeared from the population. A chi-square test on the sex ratio of collared moose, i.e. marks available for sampling, verified that there was no significant difference ($P < 0.75$) between the before- and after-impoundment periods (Table 2-5). However, the actual observations of moose wearing collars recorded significantly ($P < 0.001$) more males in the post-impoundment sample. The change in sex ratio is therefore concluded to be a sampling anomoly.

TABLE 2-5
CONTINGENCY TABLES FOR KNOWN MARKED ANIMALS AND FOR SIGHTINGS OF MARKED ANIMALS IN RELATION TO RESERVOIR FILLING DATE

	Cumulative Marks Available		Cumulative Marks Sighted	
	♂	♀	♂	♀
Pre-impoundment	44	205	3	10
Post-impoundment	626	584	6	9
Chi-square	96.5***		0.91 N.S.	

Although the samples used for sex and age analysis cover almost 8 years, the temporal distribution of these samples is not even. Approximately 50 percent of all moose observations were recorded in 1984 and by far the majority (93 percent) of non-winter (May to October) observations were in this one year. A test of monthly sex ratios for 1984 versus all other years shows a highly significant difference ($X^2 = 471.25$, $P < 0.001$). One major cause of this significance is the highly erratic sex ratios in the non-1984 years. when sample sizes are small. However, even in the winter months, which had large sample sizes, there was a marked

difference (Fig. 2-4). The proportion of males observed in 1984 rose consistently from December to April, whereas the males in the data pooled from all years declined regularly.

This observation led to further breakdown of data for all years. When cells of the frequency table of each year's sex composition by month had an expected value less than 5, that month was eliminated. On this basis, only 1984 had usable summer values so comparison was done for winter months only (Fig. 2-5). A general pattern of decreasing male observations from January to March is evident in most years. Once again, 1984 is a total exception as it rises constantly and is the only year where males observed exceeded females. This totally different pattern explains the differences observed between 1984 and other years pooled (Fig. 2-4).

But what explains the 1984 pattern and which pattern represents the true population? Are the two patterns reflecting population parameters before and after impacts associated with clearing and inundation? The intensive data collection of 1984 served the main purpose of gathering data on habitat utilization by radio-collared animals. Could the sex ratio of collared animals and the differential rate that certain animals or groups were relocated have influenced the 1984 sex ratio? The data were therefore split into components by year and by presence or absence of radio-collars (Fig. 2-6). The sex ratio for all 1984 observations (line 3) turns out to be a weighted average between the ratio for radio-collared animals (line 1) and non-radio-collared (line 2). The graph for non-radio 1984 observations (line 2) is much closer to the non-1984 pooled data (line 4) than to the combined 1984 graph (line 2). Large variation in the non-radio ratio is caused by the low sample sizes associated. Both the non-1984 and the non-radio-1984 data required some pooling of months to keep expected cell values greater than 5. However, the ratios based on

FIGURE 2-4 COMPARISON OF SEX RATIO (MALES/100 FEMALES)
FOR 1984 VERSUS ALL YEARS EXCLUDING 1984

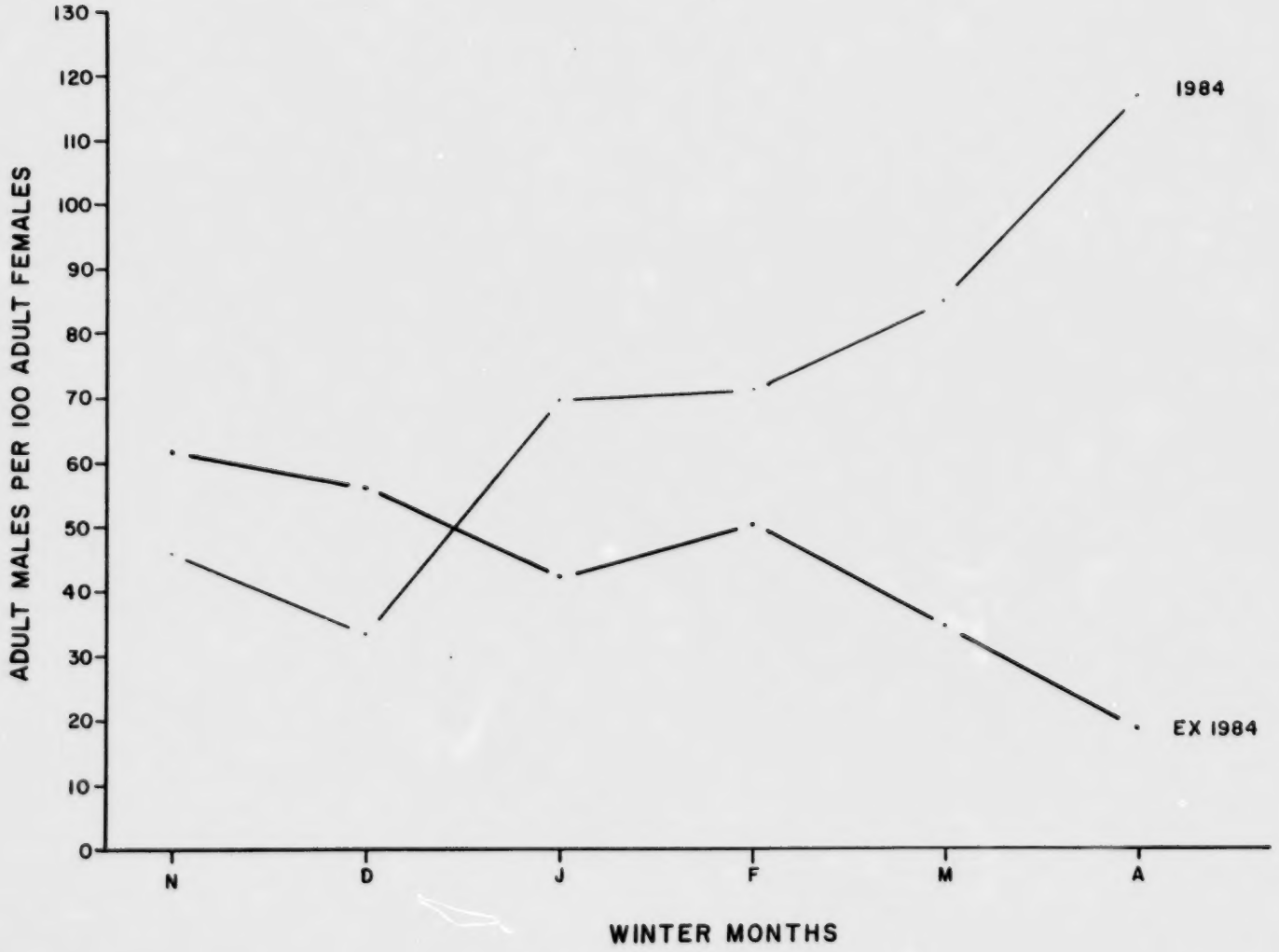


FIGURE 2-5 ANNUAL VARIATION IN OVER WINTER RATIO OF ADULT MALES PER 100 ADULT FEMALES

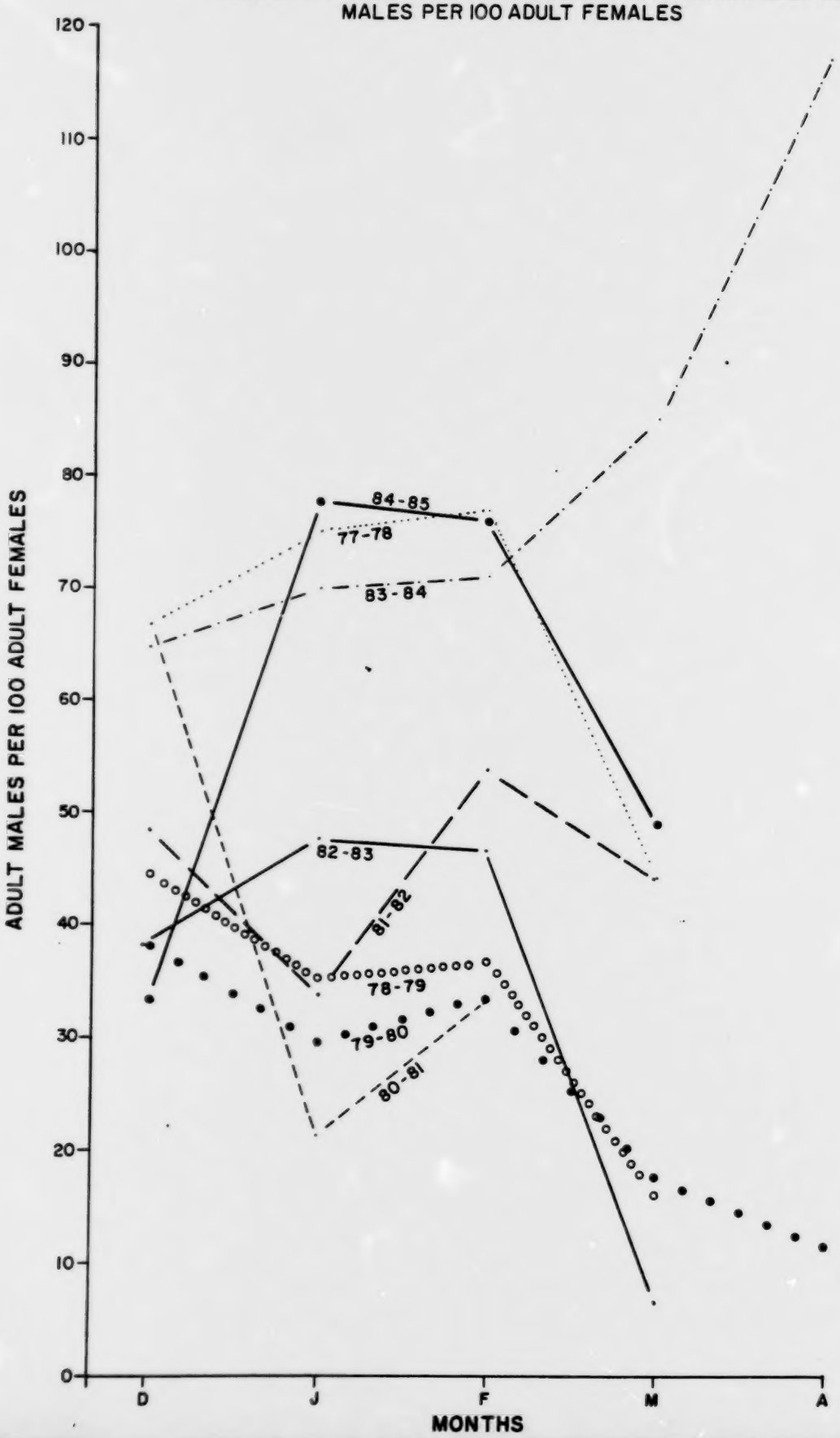
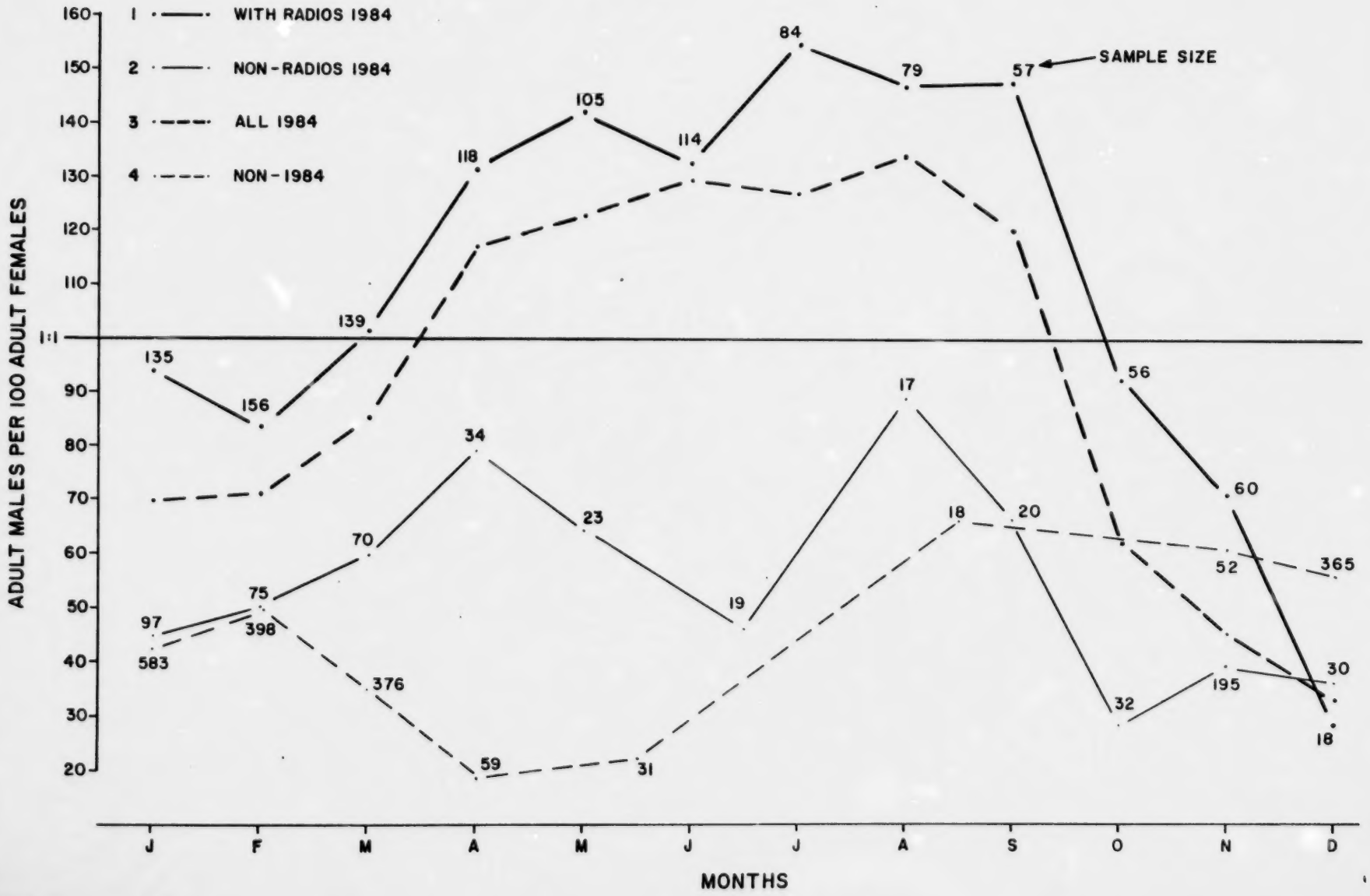


FIGURE 2-6 EFFECT OF ISOLATING SEX RATIO RELATED TO RADIO COLLARED ANIMALS FROM OTHER ANIMALS



radio-collared animals are obviously highly biased in favour of males.

Behavioural differences between male and female moose may also account for differences in observed sex ratio. Sightability, defined as the proportion of animals seen compared to the number present, is affected by habitat types and selected, group size, and elevation used (Gasaway et al., 1985).

The elevations used by males are generally higher than those used by females (Fig. 2-7) except in May and September. The seasonal changes in elevation use are the same for both sexes.

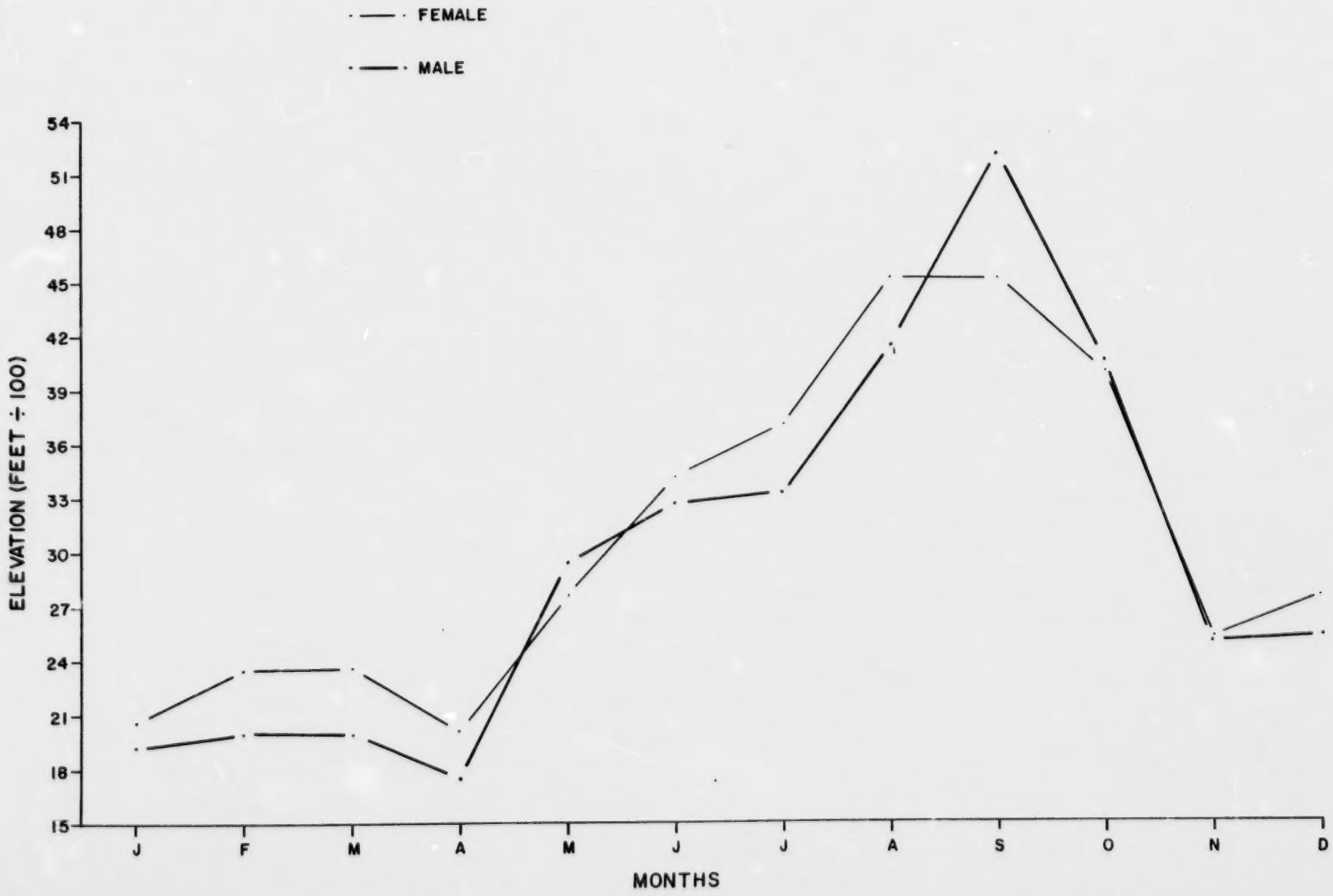
Almost half of all male and female observations were within the elevation range between the eventual floodline (1880 a.s.l.) and the upper limit of winter range arbitrarily taken as 3000 a.s.l. (Table 2-6). This band will form the post-impoundment low-level winter range.

TABLE 2-6
DISTRIBUTION OF MALES AND FEMALES IN RELATION TO FUTURE RESERVOIR LEVEL AND UPPER LIMIT OF WINTER RANGE

Elevation (feet a.s.l.)	Sex			
	Male		Female	
	n	%	n	%
< 1880	211	26.6	512	40.2
1880-3000	366	46.5	572	44.9
> 3000	216	27.2	188	14.8
	793		1272	

A larger percent of the female portion of the population were observed below the full pool level than above the 3000-foot level. However, males were equally distributed above and below this band. The chi-square evaluation of elevation and sex shows strong

FIGURE 2-7 AVERAGE MONTHLY ELEVATION USE BY ADULTS



evidence of association ($P < 0.001$). These differences in elevation use are serious enough to cause bias in the sex ratio assessments when the sampling was non-systematic and gave disproportionate coverage to a specific elevation band.

Male and female moose did not select the same habitat types for the majority of their use (see Section 4.0). Analysis of adult sex distribution in closed-canopy vegetation types (where moose were less sightable) versus non-closed types was highly significant ($P < 0.001$). For all data lumped, males occurred in closed types more frequently than would be expected in a random distribution within these closed-canopy types, the sexes were still unevenly distributed ($P < 0.0001$). Males selected the mature upland coniferous forests (especially the Englemann spruce/Subalpine fir) and the immature upland mixed conifer. Females and unclassified adults selected the mature riparian coniferous forest and the riparian alder/willow associations. Breakdown to a seasonal analysis of the closed-canopy vegetation types shows still further uneveness. For example, the Englemann spruce/Subalpine fir type preferred by males in the overall data was heavily selected in the non-winter months but avoided during the period December to March. Unfortunately, sample sizes are too small to subset use of closed-canopy types into both sex and month classes. Therefore, there is no firm evidence that visibility of sexes was biased by the selective use of vegetation types.

(c) Calf Production and Recruitment

Assessment of moose reproduction involves a variety of problems associated with techniques and sampling theory. No estimate of gross productivity exists for Revelstoke as this variable is usually related to ovarian examination of females killed by hunters. Prenatal mortality rates are usually assessed by late-pregnancy fetus rates. Neither of these sources are

available in the Revelstoke data transmitted to the Environmental and Socio-economic Services Department although some post-mortem analyses were done (R. Bonar pers. comm.).

Survival of neonatal calves is one of the indicators of quality of over-winter ranges. If the range is in poor condition, pregnancy rate declines, in utero survival declines and birth weights decline. These factors result in fewer calves being born and rapid mortality rates of those calves which are born. The sex and age structure of a population is an important basis for assessing the present condition of an animal population and for predicting the fate of that population in the near future. The methods employed on the Revelstoke project distinguished only three age classes (adults, yearlings and calves). If reservoir development has significantly reduced range carrying capacity, these types of change in population characteristics should be evident. Unfortunately controls must also be used because variations in winter severity can also cause similar results. Determination of cows-with-calves in summer presents problems of accurate age and sex identification, thereby making estimates of calf production rather unreliable in densely forested areas (Pimlott 1959).

Sampling distribution was not designed to give an accurate description of parturition timing or birth rates but still provides some information regarding the dynamics of arrival and survival of calves. The calving peak occurred in June when 26 percent of all moose observed were calves. The peak of calving occurs in June, and theoretically from then until the next year there will be a decline in calves observed per 100 adult females.

The ratio of calves per 100 females for all years combined (Fig. 2-8) follows the expected pattern (although the slope is rather steep) until October and November when the calf ratio takes a sudden and unexplained rise. From December until May a steady decline is again evident.

Is there a logical explanation for the sudden rise in calf ratio in November-December? At first, mistaken age classification of yearlings was anticipated as a contributing factor. If 6-month calves and 18-month yearlings were similar in size, then these two classes may have been added together to give a false rise in calf ratio. This theory falls apart upon scrutiny of the yearling numbers. In all months yearlings are too few in numbers to change the shape of the calf ratio graph and in fact yearlings also demonstrate the mysterious fall increase (Fig. 2-8).

The data on yearlings may, however, be valid for a year-to-year comparison, especially in a time period when misidentification is least likely. December was chosen as such a period because the sample size was large, male yearlings still carried antlers, and there was a tendancy for moose to be in groups which facilitated size comparisons. Percentages are used for comparisons because the year-to-year variation in sample size is so marked. In the latter half of the sample period there is a marked increase in the proportion of yearlings (Table 2-7). This increase is negatively correlated to a decline in calf proportions in the year previous.

FIGURE 2-8 CALVES AND YEARLINGS PER 100 FEMALES

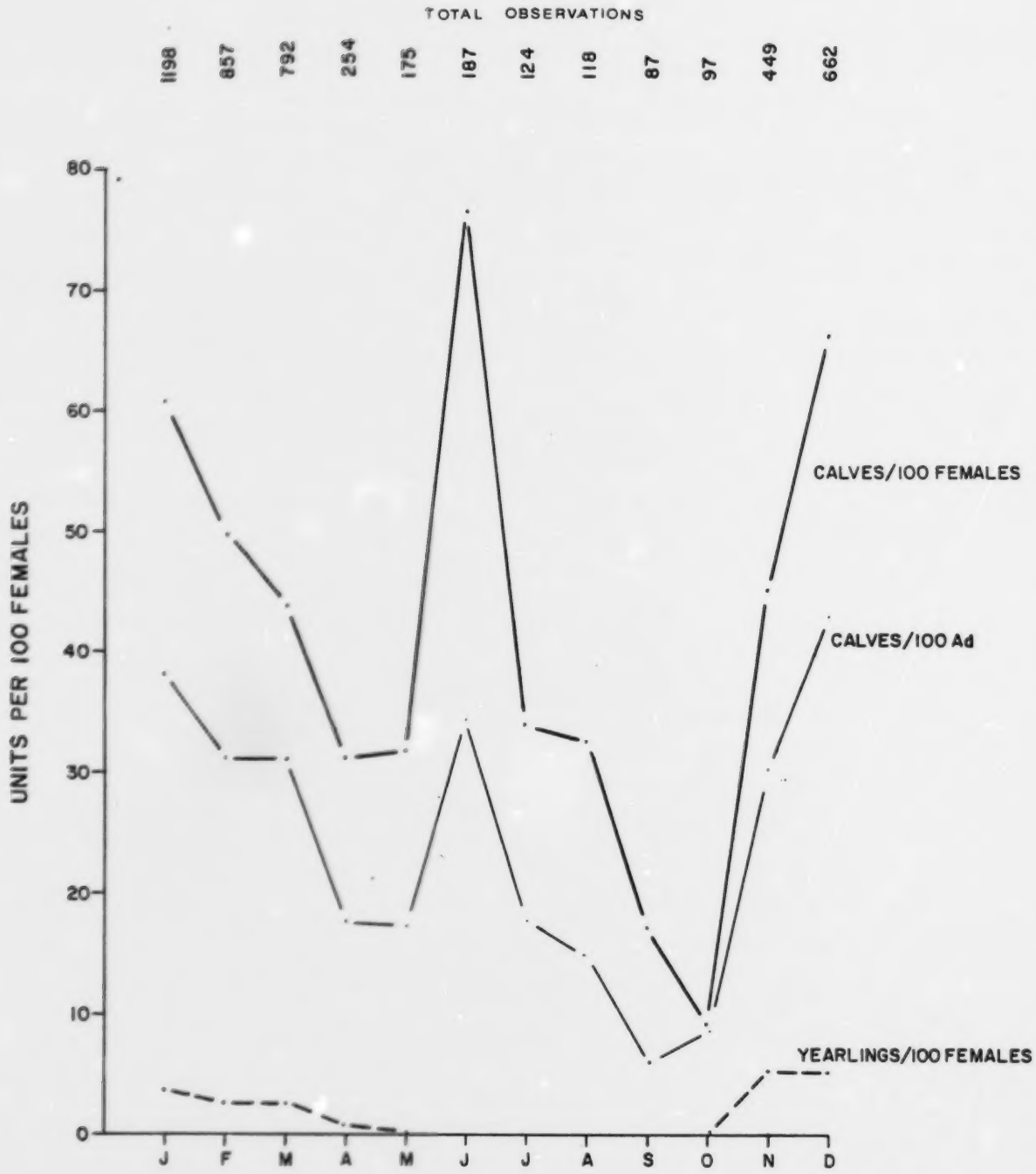


TABLE 2-7

ANNUAL VARIATION IN YEARLING AND CALF PERCENTAGES
SHOWN BY DECEMBER SAMPLES

Calves		Yearlings	
December	Percent	December	Percent
		77	7.0
77	32.6	78	6.1
78	38.8	79	8.9
79	33.9	80	5.9
80	34.1	81	9.7
81	23.3	82	18.5
82	23.2	83	13.8
83	22.5	84	10.0
84	20.3		

The percent calves in the classification of summer moose is probably biased downwards for two reasons. Firstly, the trees are in full foliage and small calves tend to be more difficult to observe than adults and secondly, no aerial surveys were included in the data. Verme (1974) cautioned that the visibility factor affects the accuracy of summer aerial counts. The cumulative moose observations for all years by months (Fig. 2-8) shows a low sample intensity during June when calving occurs and in the four subsequent months. In every year but 1984 less than 2.0 percent of the observations occurred in June (Table 2-8) and an average of 12.3 percent of the observations fell in the June to October period. The high observational proportion in the fall of 1984 has significantly boosted the annual average so the decline observed in Fig. 2-8 is a direct function of this 1-year of sampling. These data are not sufficient for an assessment of within-year variation or for comparison of years. Therefore no statistical analysis is possible for changes in birth rates caused by project development.

TABLE 2-8

PROPORTION BY YEAR OF ALL MOOSE OBSERVATIONS
IN JUNE OR THE PERIOD JUNE TO OCTOBER

	Moose Observed	June		June-October	
		Number	%	Number	%
1977	78	0	0	8	10.3
1978	234	0	0	1	0.4
1979	251	4	1.6	11	4.4
1980	415	5	1.2	8	1.9
1981	204	0	0	2	1.0
1982	667	0	0	0	0
1983	606	12	2.0	18	3.0
1984	2226	166	7.5	565	25.4
1985	319	0	0	0	0
TOTAL	5000	187	3.7	613	12.3

The monthly calf ratios for the period November to April of each year may also be subject to low sample size but still provide some insight into over-winter survival rates. Months in which fewer than 10 moose were recorded have been excluded for the purpose of this trend analysis (minimum sample size of 20 was tested with no marked change in trend). The calf ratios for this over-winter period show a general declining trend (Table 2-9) of about 12 calves per 100 females each month. Visual analysis of monthly calf ratios for the winter of each year suggested that the calving rates and survival rates for 1983/84 and 1984/85 were different than other years.

TABLE 2-9

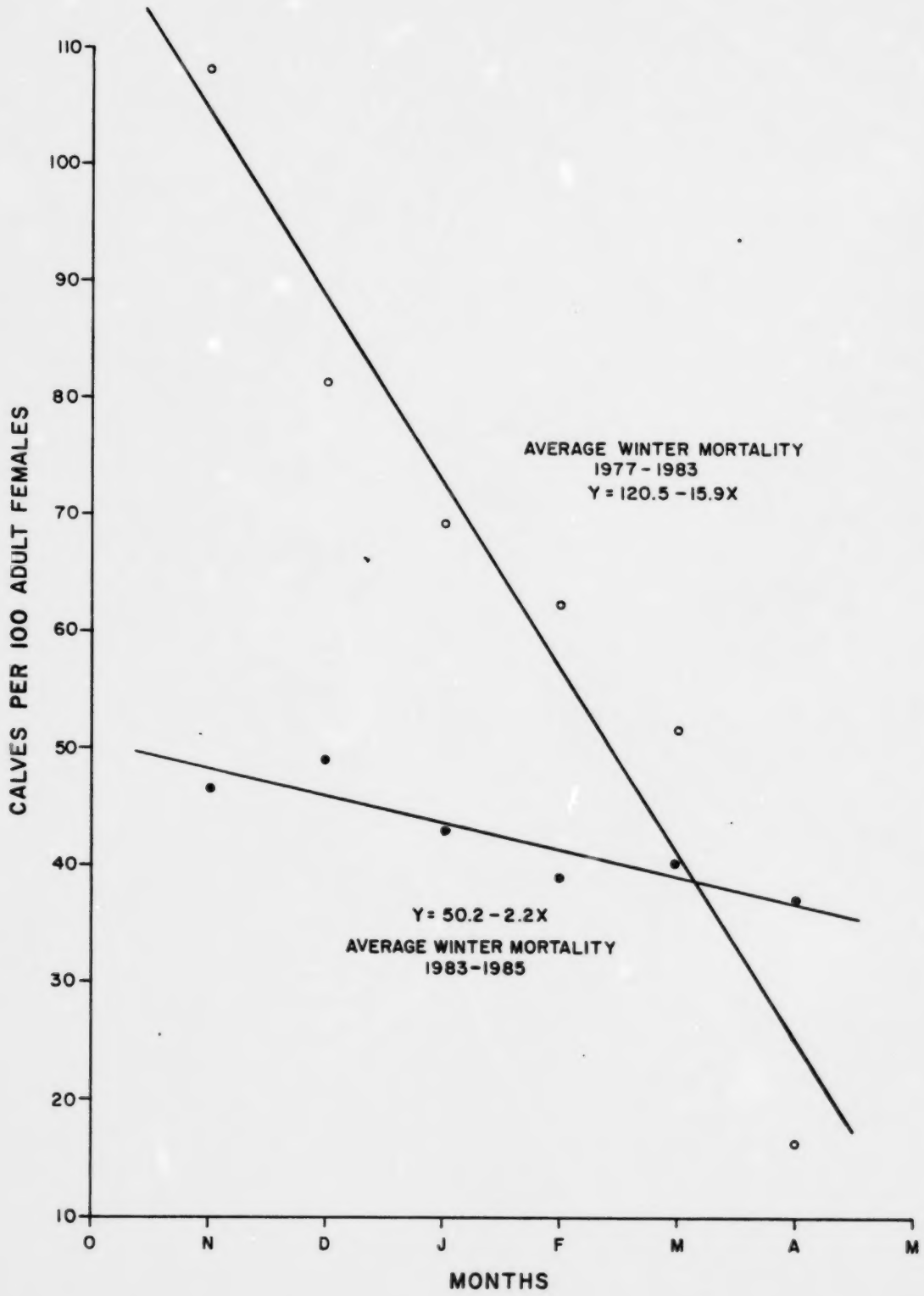
MONTHLY RATIOS OF CALVES PER 100 ADULT FEMALES
FOR THE OVERWINTER PERIODS FROM 1977 to 1985

Year	Nov	Dec	Jan	Feb	Mar	Apr
1977-78	114	93	68	85	100	-
1978-79	-	106	100	67	28	18
1979-80	125	86	52	42	35	15
1980-81	86	87	50	71	64	-
1981-82	-	52	73	31	36	-
1982-83	-	65	73	79	47	-
1983-84	56	59	48	35	49	37
1984-85	37	39	38	43	32	-
AVERAGE	83.6	73.4	62.8	56.6	46.4	24.0

If the hydroelectric development has removed essential winter range, then some proportion of the cow moose population could have undergone physiological stress which would in turn have reduced birth rates and calf survival rates. A regression analysis (Fig. 2-9) of combined years 1977-83 compared with 1983-85 demonstrates highly different ($t = 6.4$, $P < .001$) slopes. This grouping of years roughly coincides with pre-filling and filling periods (filling commenced on 11 October 1983 and reached 98 percent full by 1 April 1984). Fewer calves entered the winter period once the reservoir existed but their month-to-month survival was higher with a resultant spring calf per adult female ratio approximately equal to that of the pre-filling period. This significant difference cannot be interpretted as proof of an impoundment effect without comparative data on a control area with similar year-to-year changes in winter conditions.

In some respects, there is a partial control built into the sampling procedures. The monthly samples do not represent a random sample of the population because of the strong bias towards repeated observations of up to 16 marked cow moose. If the calving ratio, real or observed, of marked cows was different than

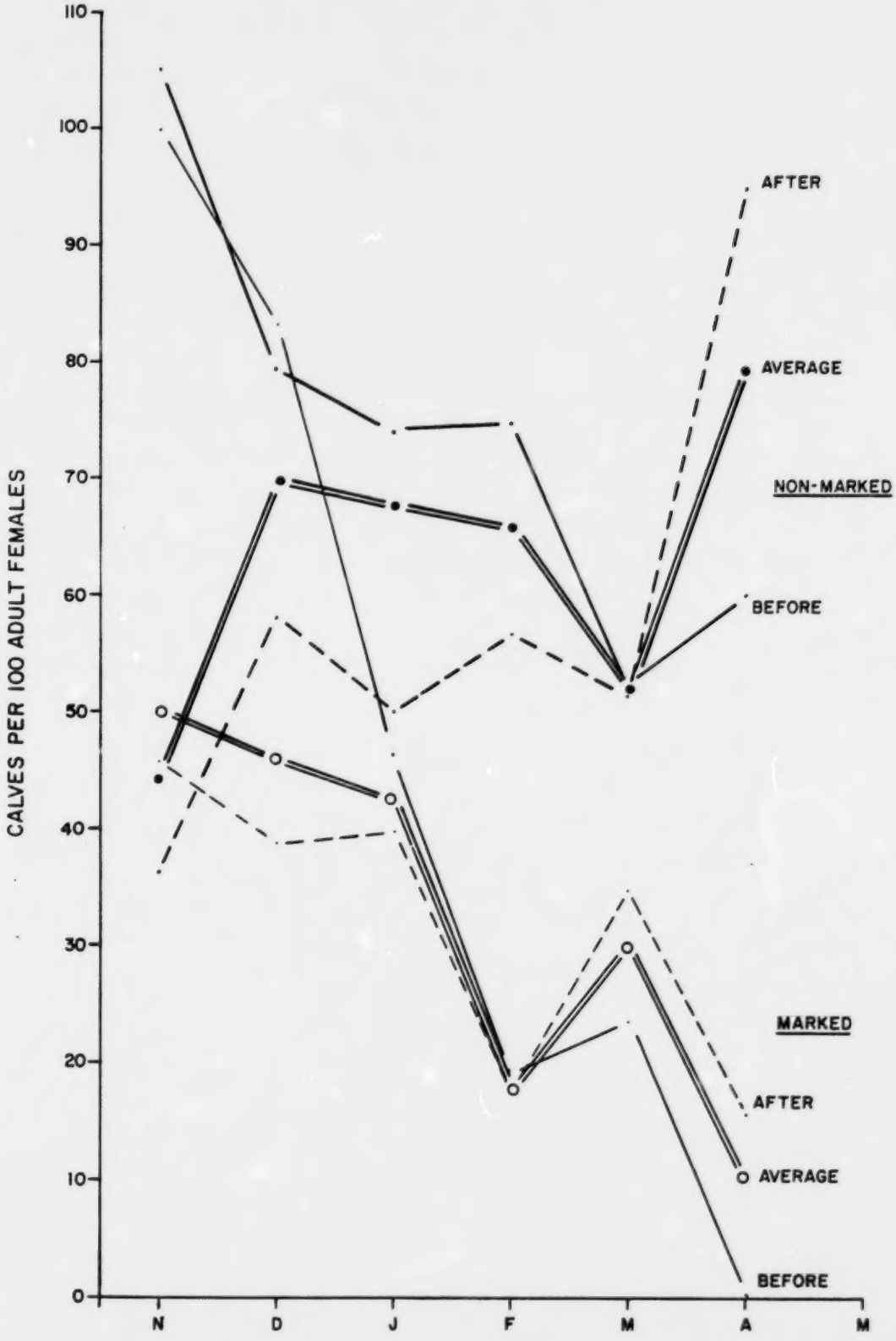
FIGURE 2-9 REGRESSION OF CALVES/100 FEMALES AGAINST TIME OVER THE WINTER MONTHS FOR PRE- AND POST- IMPOUNDMENT PERIODS



that of non-marked cows then this bias would affect the overall calf ratio. For the winter season the ratio of calves in the non-marked population is on average higher than in the marked animals (Fig. 2-10), although the November-December samples are similar. The null hypothesis is that calving rates in the marked and non-marked portions of the population should be equal. This hypothesis is rejected because the chi-square value for the test is highly significant ($X^2 = 56.86$, $P < .0001$). The marks used in this analysis are of two basic kinds, neck collars/physical marks and radio-tracking devices. The time periods within which these two mark types were most prominent were different. Visual markers were used exclusively prior to March 1983 and radios made up the bulk of marked observations after this date. The comparison of calf ratios for marked and non-marked animals within both of the time periods were significantly different ($X^2 = 36.2$ before, 89.1 after, both $P < .0001$). The radiotracking technique should theoretically provide the best estimate of survival, so data for animals marked in the pre-radio era were compared to those for the post-radio era. No significant difference could be detected ($X^2 = 0.83$, N.S.). Differences in calf ratios of non-marked animals for the same two time periods were highly significant ($X^2 = 68.5$, $P < .0001$), so without the benefit of radio-tracking observations one may well have erroneously concluded that there was an impact-related drop in calf production and survival. Instead the differences in regression equations for mortality (Fig. 2-9) may be reflecting a bias attributable to study design. After radio use became prevalent, 47 percent of the cow-calf observations involved the 16 or fewer marked cows being resighted. In contrast, only 16 percent of the pre-radio observations recorded marked moose.

Chi-square analysis of age-class observations before and after impoundment show a significant ($P < 0.001$) difference in the calves per unit population as the ratio dropped from 28 percent

FIGURE 2-10 COMPARISON OF OVER WINTER CALF RATIOS FOR MARKED AND NON-MARKED MOOSE FOR THE TIME PERIODS BEFORE AND AFTER THE USE OF RADIO COLLARS IN THE REVELSTOKE VALLEY



calves before to 18 percent calves after impoundment. The yearling ratio change (6 percent to 5 percent) was not significant. Separate analysis between monthly periods for winter month calf percentages was highly significant ($P < 0.001$) from November to February (except December $P < 0.05$) but was non-significant for March and April. This analysis confirms the regression analysis which showed a reduced calf production entering the winter but a higher survival of calves during the winter.

Regardless of the validity of the pre- and post-impoundment comparison, the regression equation for calf ratios of radio-marked animals should be an accurate measure of mortality. The equation, with June as month zero is

$$Y = 90.6 - 7.7X$$

indicating an average loss of 7.7 calves per 100 adult females each month from a June calf ratio of 90.6 per 100 adult females. The latter figure represents a back extrapolation applying the observed winter mortality to each of the summer months and would be expected to be a low estimate of the actual birth ratio.

The observed calf production of the Revelstoke project is consistent with other studies (Table 2-10) reported by Thompson et al. (1980). The composition of the fall population (Sept.-Dec.) for all years was 74.3 percent adult, 23.6 percent calves and 2.1 percent yearlings. Lower calf percentages have been recorded in B.C. by several studies in areas generally known for their excellent moose populations. Goulet and Haddow (1985) observed 7.5 percent calves in a helicopter survey of 239 moose in February in the Liard River valley. Lincoln (1979) observed 13 percent calves along the B.C. portion of the Alaska Highway Gas Pipeline Project and a later study in the same area by Searing and Roland (1982) record 6-7 percent calves. Silver (1976), working in the Halfway River, northwest of Ft. St. John recorded 17 percent. Just north of the B.C. border in the Yukon, Larsen (1982) and Johnston et al. (1984)

TABLE 2-10

COMPOSITION OF FALL MOOSE POPULATIONS IN VARIOUS AREAS OF NORTH AMERICA
(ADAPTED FROM THOMPSON ET AL. 1980)

Location	Females Per Male	Composition of Fall Population			Source
		% Adults	% Yearlings	% Calves	
North-central Alberta	2.7	74	NA[a]	26	Lynch (1973)
Peace River, British Columbia	2.4	52	NA	48	Penner (1976)
Alberta	3.7-4.8	83	NA	17	Hall et al. (1973)
Rochester, Alberta	2.4	44	16	40	Frokjer and Keith (in prep.)
Elk Island Park, Alberta	1	61	18	21	Blood (1966)
Ontario	1	57	18	25	Simkin (1974)
Newfoundland	0.9	60	18	22	Pimlott (1959)
Newfoundland	-	NA	NA	23-29	Mercer (1974)
British Columbia	1	60	18	22	Edwards and Ritcey (1958)
British Columbia	2.2	78	NA	22	Finegan (1973)
Tanana Flats, Alaska (1960, 1966)	1.2-2.3	59-81	4-21	15-50	Bishop and Rausch (1974)
Nelchina Basin, Alaska (1953, 1963, 1972)	0.9-5.7	46-82	5-25	13-29	Bishop and Rausch (1974)
Northeastern Minnesota (1969, 1970)	1.0-1.3	69-73	8-12b	19	Peek et al. (1976)
OASERP Study Area					
Syncrude Lease No. 17	1:1.3	68	NA	32	Penner (1976)
Bitumount Study Area (1976, 1977)	-	71-81	NA	19-29	Hauge et al. (in prep.)
Syncrude Study Area (1976, 1977)	-	70-81	NA	19-30	Hauge et al. (in prep.)

[a]NA = category not used.

[b]Estimated based on double the proportion of yearling males.

observed compositions of 12 percent and 9 percent calves respectively. Several other B.C. studies have recorded calf percentages of the same magnitude as the Revelstoke study. These include Finegan's (1973) 21 percent, Edwards and Ritcey's (1958) 22 percent, and an observation of 25 to 33 percent by LGL Ltd. (1982). Van Ballenberge recorded variations from 11 to 32 calves per 100 cows during 8 years and explained some of the variation by winter severity and changing predator densities. One striking observation was an extremely low fall calf ratio of 13 in 1975 followed by an extremely strong long yearling ratio the following year. A differential group size factor was speculated as cause for the low calf observation rate in 1975. The highest calf percentage located in the literature was 48 percent recorded along the Peace River in Alberta (Penner 1976).

Another population parameter which can be used as an indicator of the status of the environment within which an animal lives is the twinning rate. A healthy fertile moose population reflects an environment which is superior to one where the moose population is less fertile (Franzmann and Schwartz 1985). For the purpose of comparison with other studies, both the rate based on cows with calves and also the rate based on total cows are reported (Table 2-11). In total there were 204 observations of twins for 2133 cows which is only 9.6 percent. For fall samples (November/ December) 55 of 465 (11.8 percent) cows had twins and 55 of 210 cows with calves (26.2 percent) had twins. This twinning rate compares with that recorded in Alaska for a low quality burn habitat by Franzmann and Schwartz (1985) where 22 percent of the cows with calves had twins. None of the annual production rates, even pre-impoundment, compared to the 70 percent of fecund females which produced twins on the highly productive burns in the above Alaskan study. One must bear in mind that the Alaska data were collected immediately post-parturition before the influences of calf mortality whereas the Revelstoke ratios, because of small

June samples sizes, include 1/2 year of calf mortality. Several moose studies in Alaska have recorded summer mortality rates of 57 to 68 percent (Franzmann et al. 1980, Gasaway et al. 1977 and Le Resche 1968). These studies occurred in an area with an abundant black bear population which accounted for a large proportion of the deaths. Comparable calf mortality near Revelstoke would infer a twinning rate in the order of 70 percent but a lesser mortality may even be reasonable because the Revelstoke valley does not have an abundant predator population.

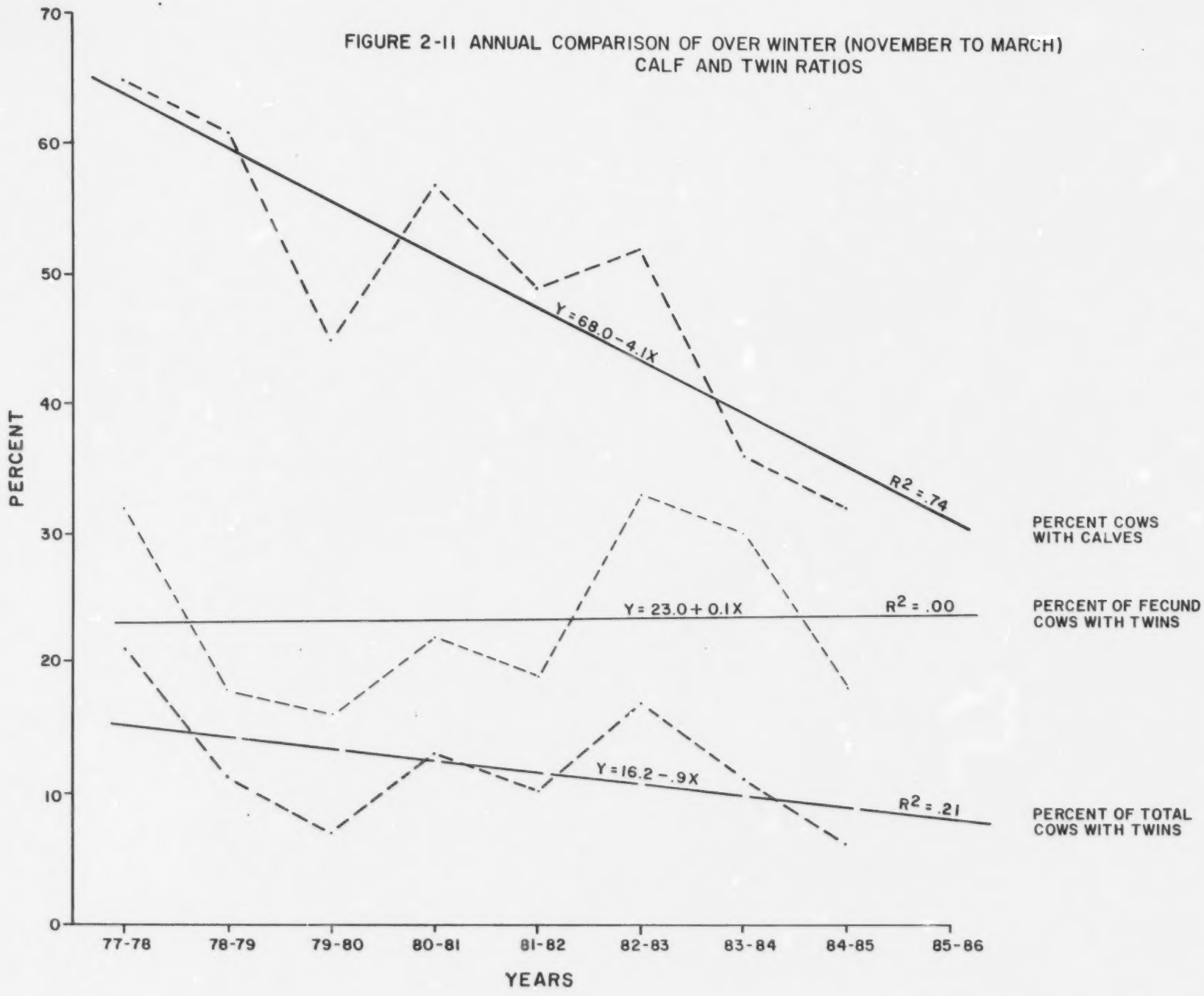
TABLE 2-11

CALVING AND TWINNING RATES FOR NOVEMBER/DECEMBER SAMPLES OF EACH YEAR

Year	Cows Observed	Cows With Calves	Cows With Twins	% Cows With Calves	% Cows With Twins	% of Fecund Cows With Twins
1977	22	15	7	68.2	31.8	46.7
1978	22	19	4	86.4	18.2	21.1
1979	25	18	5	72.0	20.0	27.8
1980	37	23	9	62.2	24.3	31.1
1981	31	13	3	41.9	9.7	23.1
1982	20	10	3	50.0	15.0	30.0
1983	97	45	12	46.4	12.4	26.7
1984	211	67	12	31.8	5.7	17.9
TOTAL	465	210	55	45.2	11.8	26.2

Earlier analyses demonstrated that the calf ratio per 100 adult females appears to decline after impoundment, but a bias factor related to emphasis on radio-tracking was identified. However, twinning rates do not demonstrate the same degree of decline (Fig. 2-11). Twins expressed per female with calves did not appear to change at all although there was so much annual variation that the correlation coefficient was effectively zero. Twins expressed as a percent of all cows observed did decline gradually, again with marked annual variation. The difference between the decline in cows with calves and the apparent

FIGURE 2-11 ANNUAL COMPARISON OF OVER WINTER (NOVEMBER TO MARCH)
CALF AND TWIN RATIOS



stableness of cows with twins may be a function of the radio-tracking bias as "WENDY" was the only radio-collared cow to have twins and these were only observed on nine occasions. Habitat removal associated with reservoir clearing may also be having a differential effect on these two variables. The reduction of low elevation winter range may limit the number of moose which actually bear calves but have no influence on the proportion of fecund cows which produce twins. The stress-related effect of overpopulation or reduced food supply would probably not be significant until a "severe winter" condition were observed.

(d) Group Composition and Size

Group composition and size are indicators of the behavioural mechanisms within the population and are important because they affect the visibility of moose during aerial surveys. A group was defined by the field researchers as an aggregation of individuals within 50 m of each other. Two groups of eight animals represent the largest aggregations observed and these were in November and December. The average monthly group size was lowest for August (1.19) and highest for October (2.07). Overall average group size was 1.71 moose. Lone animals accounted for 28.5 percent of all animals and 48.6 of all group sightings. Groups of three or less contributed 93.5 percent of all moose observed. The peak in group size coincides with the rut period in October/November and a small but obvious increase occurred in June when calving peaked. Contingency analysis of group size versus time in months resulted in a large number of cells with expected values less than five. However, the data do suggest a gradual overwinter decline in group size. To test this hypothesis, I merged all groups of three or more and limited the data to winter observations. These limitations still retained 86.3 percent of all moose observed. The chi-square test of independence determined that group sizes do not remain constant through time ($X^2 = 132.3$, $P < 0.001$). Forty

percent of the contribution of this chi-square value came from December when lone animals were under-represented and groups of three or more were over-represented (Table 2-12).

TABLE 2-12

CONTRIBUTION BY MONTH AND GROUP SIZE TO THE COMPOSITE CHI-SQUARE VALUE*

	Dec.	Jan.	Feb.	Mar.
Lone	(-) 14.6	(-) 7.1	11.0	6.7
Two	10.3	4.5	(-) 17.9	3.8
3 Plus	27.5	6.4	(-) 10.4	(-) 10.9

* Sign (-) indicates that the average observed value for the 8 years is less than the expected value.

In January, lone animals were still under-represented but by February and March it was the larger groups that were less frequent. In fact, over the winter period the group size was negatively correlated (r = 0.93) with time as the percent of lone animals increased (Table 2-13).

TABLE 2-13

SIZE OF MOOSE GROUPS FOR WINTER PERIODS (1977 TO 1985)

Month	No. of Moose	No. of Groups	Mean Group Size	Percent of Moose Per Size Class 1	2	3	4	5	6	7	8
Nov	438	221	1.98	18.7	38.4	28.8	8.2	1.1	1.4	1.6	1.8
Dec	654	335	1.95	19.0	40.4	28.0	8.0	1.5	0.9	1.1	1.2
Jan	1122	659	1.70	27.3	46.3	20.6	5.3	0.4			
Feb	754	455	1.66	30.8	41.4	23.9	3.2	0	0.8		
Mar	692	421	1.64	30.5	45.1	21.2	1.7	1.4			

Gasaway et al. (1985) found that the sightability of moose increased with group size and, therefore, large groups had a greater likelihood of being spotted than small groups. Once one animal is observed, others are often tallied during the low passes for sex and age identification. Secondly, standing moose are

easier to see than bedded moose and as group size increases the probability of all animals being simultaneously bedded decreases. Therefore, for management purposes, surveys in November/December when group size is highest should provide the best sampling conditions from an animal behaviour viewpoint.

The annual variation in group size for winter periods is not significant ($X^2 = 24.6$, $P < 0.25$). The annual average group size only varied from 1.6 to 1.8 for the 8 years of data. There is, therefore, no obvious change in group size resulting from project development.

(e) Habitat Occupancy

Whenever possible, the habitat occupied by each animal was recorded. If the moose was on the ecotone between two habitat types (Table 2-14) then both types were recorded under the variable "ecotone". Some analyses look at the occupancy of each individual type but for most analyses the types have been grouped.

A key analysis compares the observed occupancy of types with the actual areal extent of each type. For this analysis, each habitat type was assigned to one of six habitat classes: mature coniferous, immature mixed, alpine, riparian mixed, wetland, and cleared (Table 2-14). This assignment was based on the subjective description of each type and should not be construed as definitive.

These classes were assigned to match as close as possible the major types which were used for computing habitat areas within the reservoir (Table 2-15). An exact match was not possible because some of the upland types above the eventual floodline were not represented within the reservoir area.

TABLE 2-14

DESCRIPTIVE PARAMETERS USED IN ANALYZING HABITAT OCCUPANCY

Code	Description	Major Plants	No. of Samples	Maturity	Sucessional Stage	Habitat Class	Canopy Closure
01	Upland Coniferous Forest	Cedar/Hemlock	540	M	Mature	M. Conif.	C
02	Upland Coniferous Forest	Spruce/Subalpine Fir	168	M	Mature	M. Conif.	C
03	Subalpine Meadow/Forest Complex	Subalpine Fir-Forbs-Sedges	2*	0	Mature	Alpine	N
04	Krumholtz	Subalpine Fir-Forbs	0*				
05	Subalpine Meadow-Wetter Site	Forbs, Sedges	0*				
06	Alpine Tundra	Forbs, Sedges, Grasses	1*	M	Mature	Alpine	N
07	Alpine Cliffs, Bluffs	Grasses, Sedges, Forbs	0*				
08	Subalpine Cliffs, Bluffs	Subalpine Fir-Forbs	0*				
09	Snowfield or Glacier		0*				
10	Alder Slide	Sitka Mountain Alder, Willow	86	0	Seral	Imm. Mixed	C
11	Forb Slide	Forbs	5*	0	Seral	Imm. Mixed	
12	Upland Mixed Coniferous Forest	Cedar, Hemlock, Fir, Pine	57	0	Immature	Imm. Mixed	C
13	Upland Mixed Deciduous Forest	Aspen, Birch	6*	0	Immature	Imm. Mixed	C
14	Riparian Coniferous Forest	Cedar, Spruce, Hemlock	154	M	Mature	Rip. Mixed	C
15	Riparian Mixed Forest	Conifers, Cottonwood, Birch	58	M	Mature	Rip. Mixed	C
16	Riparian Deciduous Forest	Cottonwood, Forbs, Grasses	13*	0	Seral	Rip. Mixed	C
17	Riparian Alder/Willow Brush	Willow, Alder, Forbs	230	0	Seral	Rip. Mixed	C
18	Non-vegetated Riparian Margin		127	0	Seral	Wetland	N
19	Upland Selective Logging	Hemlock, Shrubs	119	0	> 10 yrs old	Cleared	N
20	Riparian Selective Logging	Hemlock, Shrubs	170	0	> 10 yrs old	Cleared	N
21	Riparian Clearcut	Shrubs, Forbs, Grasses	79	0	> 10 yrs old	Cleared	N
22	Upland Clearcut	Willow, Birch	481	0	> 10 yrs old	Cleared	N
23	Riparian Clearcut	Forbs, Shrubs	22*	0	5-10 yrs old	Cleared	N
24	Upland Clearcut	Forbs, Grasses	161	0	5-10 yrs old	Cleared	N
25	Riparian Clearcut	Forbs, Grasses	5*	0	< 5 yrs old	Cleared	N
26	Upland Clearcut	Fireweed, Grasses	50	0	< 5 yrs old	Cleared	N
27	Road		48	0	Seral	Cleared	N
28	Road Right-of-Way (R/W)	Shrubs, Grasses, Forbs	48	0	Seral	Cleared	N
29	Transmission Line R/W	Grasses, Forbs	2*	0	Seral	Cleared	N
30	Non-vegetated Cleared Area		10*	0	Seral	Cleared	N
31	Agricultural Land	Grasses, Sedges	1*	0	Seral	Cleared	N
32	Upland Selective Logging	Hemlock, Shrubs	14*	0	< 5 yrs old	Cleared	N
35	Garbage Dumps, Construction Camp	Forbs-Grasses	0*	0		Cleared	
36	Recent Burn < 25 years	Spruce-Alder-Sedges	172	0	Seral	Wetland	N
37	Spruce/Alder/Carex Wetland	Spruce-Alder-Carex	60	0	Seral	Wetland	N
38	Sedge Meadow	Sedges	5*	0	Seral	Wetland	N
39	Sandbar Willow Association	Willow	1*	0	Seral	Wetland	N
40	Pond, Creek, River		60	0	Seral	Wetland	N
41	Upland Mixed Immature Forest	Grasses, Shrubs, Forbs	74	0	Immature	Imm. Mixed	N
42	Upland Selective Logging	Cedar, Fir, Hemlock	2*	0	5-10 yrs old	Cleared	N
43	Riparian Selective Logging	Cedar, Spruce, Hemlock	9*	0			
44	Riparian Selective Logging	Cedar, Spruce, Hemlock	10*	0	<5 yrs old	Cleared	N
45	Reservoir		9*	0	5-10 yrs old	River	N
			3059				

* Samples lumped into Miscellaneous class for Chi-square analysis.
M - Mature O - Not Mature C - Closed N - Not Closed

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TABLE 2-15

AREAS OF MAJOR HABITAT TYPES WITHIN THE RESERVOIR AREA*[1]

Habitat Type	Area (km^2)	Proportion (excl. river)
River	21.0	
Wetlands including River Margins Gravelbars, Drawdown Zones	9.6	10.1
Mature Coniferous Upland Forest	32.9	34.8
Immature Mixed Upland Forest	0.3	0.4
Riparian Mixed Forest	3.4	3.6
Cleared, Logged or Burned	48.3	51.2
TOTAL	115.5*[2]	
Excluding River	94.5	

*[1] Habitat types measured by planimeter from 1:15 000 scale orthophotomosaics 14 October 1977 photography.

*[2] Total does not include the reservoir area for lower Downie Creek because there is no orthophoto for that area. The area defined did not include any alpine habitat.

Because of this mis-match, expected occupancy values were generated by multiplying the habitat class proportions (Table 2-15) by the total observations. Comparisons of observed use related to use expected on the basis of areal extent were highly significant for areas below floodline and areas at all elevations (Table 2-16).

TABLE 2-16

COMPARISON OF OBSERVED USE OF HABITAT CLASSES
WITH AREAL EXTENT OF EACH CLASS

Habitat Class	Below Floodline			All Elevations		
	Observed	Expected*	X^2	Observed	Expected*	X^2
Cleared	1130	1094	1.2	1670	1720	1.5
Immature	65	9	354.1+	144	13	1311.1+
Mature	335	774	224.5-	742	1170	156.3-
Riparian	343	77	919.4+	476	121	1041.6+
Wetland	264	216	10.7	329	339	0.3
TOTAL	2137		1509.9***	3361		2510.8***

* Expected value calculated using areal proportion times observed total (e.g. Cleared: 0.512 x 2137 = 1094) chi-square for 4 degrees of freedom at 9.9 percent is 18.5).

Heavy selection of riparian and immature types occurs for both elevation categories. There is also a significant lack of use of mature types. Types cleared by logging or burning and wetland types were used approximately as expected. Breakdown of the observations below floodline into age classes gave similar results with one slight exception. Use within the cleared habitats was less than expected for adults and more than expected for yearlings.

Other assessments do not relate directly to groupings based on obvious structure or food materials utilized but simply report the habitat occupied at time of observation. Analyses are presented

TABLE 2-17

RANKING OF THE TEN MOST-FREQUENTED AND CONSISTENTLY USED HABITATS BASED ON 3059 ADULT MOOSE OBSERVATIONS

	Habitat Type	Percent of Use	5%	10%	20%	30%	40%
01	Upland Coniferous - Hemlock/Cedar	17.6	12	10	5	1	-
22	Upland Clearcut > 10 years	15.7	11	11	2	2	-
17	Riparian Alder-Willow	7.5	4	2	-	-	-
36	Recent Burn	5.6	6	3	-	-	-
20	Riparian Selective Logging	5.5	3	1	-	-	-
02	Upland Coniferous - Spruce/Fir	5.5	6	5	4	2	2
24	Upland Clearcut 5-10 years	5.2	5	1	-	-	-
14	Riparian Coniferous	5.0	4	1	-	-	-
18	Non-vegetated Riparian Margin	4.1	2	-	-	-	-
19	Upland Selective Logging > 10 years	3.9	5	-	-	-	-
	Other 29 Types	24.4	10	1	-	-	-

of habitat occupancy by time, by sex, by elevation and by age. Other comparisons are possible but are not deemed as important. The occupancy observations cannot be literally interpreted as selection or avoidance because the proportion of each type sampled has not been recorded. Also, visibility within the types varies significantly and may cause an apparent distributional difference.

The ten most frequented habitat types represent about 75 percent of the 3059 observations of use (Table 2-17). "The 01 Upland Coniferous Hemlock/Cedar" and "22 Upland Clearcut >10 years" contributed one-third of all observations. The next six types in rank contributed 5 to 8 percent each. Table 2-16 also shows that occupation of the top two types is high throughout the year (i.e. 10 or 11 months where more than 10 percent of all observations occurred in the specified type). Peak use of these two types differed considerably. The closed-canopy hemlock/cedar forest was most heavily used in the spring to summer period April/May/June and the old clearcut showed bi-modal use with peaks May/June/July and November/December. The "02 Upland Coniferous Spruce/Fir" type also warrants special mention although annual use only totalled 5.5 percent. Use of this type lasted from May to October and reached higher single-month peaks (41.9 percent in August and 47.2 percent in September) than any other habitat types.

Even in the moderately used habitat types the seasonal use factor is evident. Four types had low but fairly consistent all-year occupation:

- "19 Upland Selective Logging >10 Years"
- "26 Upland Clearcut <5 Years"
- "27 Roads"
- "28 Road Right-of-Ways"

The "41 Upland Mixed Immature Forest" had fairly low winter/spring use which peaked at about 6 percent in May. Three of the riparian types, "14 Riparian Coniferous Forest" and "17 Riparian Alder/ Willow Brush" and "40 Pond, Creek, River" peaked in later winter to early spring. Two of the upland logged areas seemed to be used in association with seasonal migration. The Upland Clearcuts (Types 22 and 24, aged 5 to 10 years and >10 years respectively) received peaks of use in June and then again in November. Three disturbed or early seral types exhibited peaks in the fall. The "10 Alder-dominated Slide", "36 Recent Burns <25 Years", and "37 Spruce/Alder/Carex Wetland Association" types had peaks in September/October. The use of the wetland association continued on into early winter. In the winter, two types in addition to the "01 Upland Coniferous Forest" had peak observations. The "20 Riparian Selective Logging >10 Years" and the "18 Non-vegetated Riparian Margin" had no use at all from May to November but high use from December to March.

Much of the preferential seasonal use of habitat types seems to be closely linked with the altitudinal migration of moose. Unfortunately, no data are available on the altitudinal distribution of habitat types so use of different elevations within each habitat type is used as a basis for this analysis. Once again the ten most frequented types are assessed so sample size is not prohibitively small. For each month the proportion of moose within each type is calculated by dividing the observations within the type by all observations for the month (Table 2-18). Graphs of the monthly proportions for each habitat type illustrate the differential seasonal use and seem to show a progressive movement of peak use through different types. Many of the graphs are bi-modal and suggest that moose move through such a type on the way to and from the summer range (e.g. "01 Upland Coniferous Forest Cedar/Hemlock" in May and September and "22 Upland Clearcut >10 Years" in June and November, Fig. 2-12. Arrival on the summer

TABLE 2-18

PROPORTIONAL DISTRIBUTION OF MONTHLY OBSERVATIONS
WITHIN THE TEN MOST-FREQUENTLY OCCUPIED HABITAT TYPES

	Habitat Type	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total Obs.
01	Upland Coniferous Cedar/Hemlock	13.0	21.0	17.8	28.1	35.6	26.7	14.1	9.7	20.8	13.3	15.2	8.8	540
22	Upland Clearcut > 10 years	10.3	12.5	11.0	16.2	19.7	32.8	16.2	10.8	1.4	10.0	38.3	20.7	481
17	Riparian Alder/Willow Brush	5.5	7.8	18.6	14.6	3.8	0.8	4.0	2.2			3.7	2.5	230
36	Recent Burn < 25 years	4.8	1.3	3.7	6.0	1.5	0.8	1.0	7.5	13.9	18.9	7.8	16.1	173
20	Riparian Selective Logging > 10 years	10.4	3.4	9.2	1.1								10.9	170
02	Upland Coniferous Spruce/Fir			1.4	1.1	8.3	16.0	29.3	41.9	47.2	27.8			168
24	Upland Clearcut 5-10 years	7.8	6.0	0.8	0.5	2.3	3.1	7.1	4.3		3.3	10.7	8.1	161
14	Riparian Coniferous Forest	6.8	7.5	5.3	12.4		0.8			4.2	2.2	3.3	1.1	154
18	Non-vegetated Riparian Margin	9.1	3.7	5.5	1.1			2.0					4.2	127
19	Upland Selective Logging > 10 years	2.0	6.2	3.7	4.3	6.8	8.4	7.1	3.2	4.2	5.6	0.8	1.8	119
														2323
	Percent of Total	69.7	69.4	77.0	85.4	78.0	89.4	80.8	79.6	91.7	81.1	79.8	74.2	75.7
	Total Observations	690	537	511	185	132	131	99	93	72	90	243	285	3068

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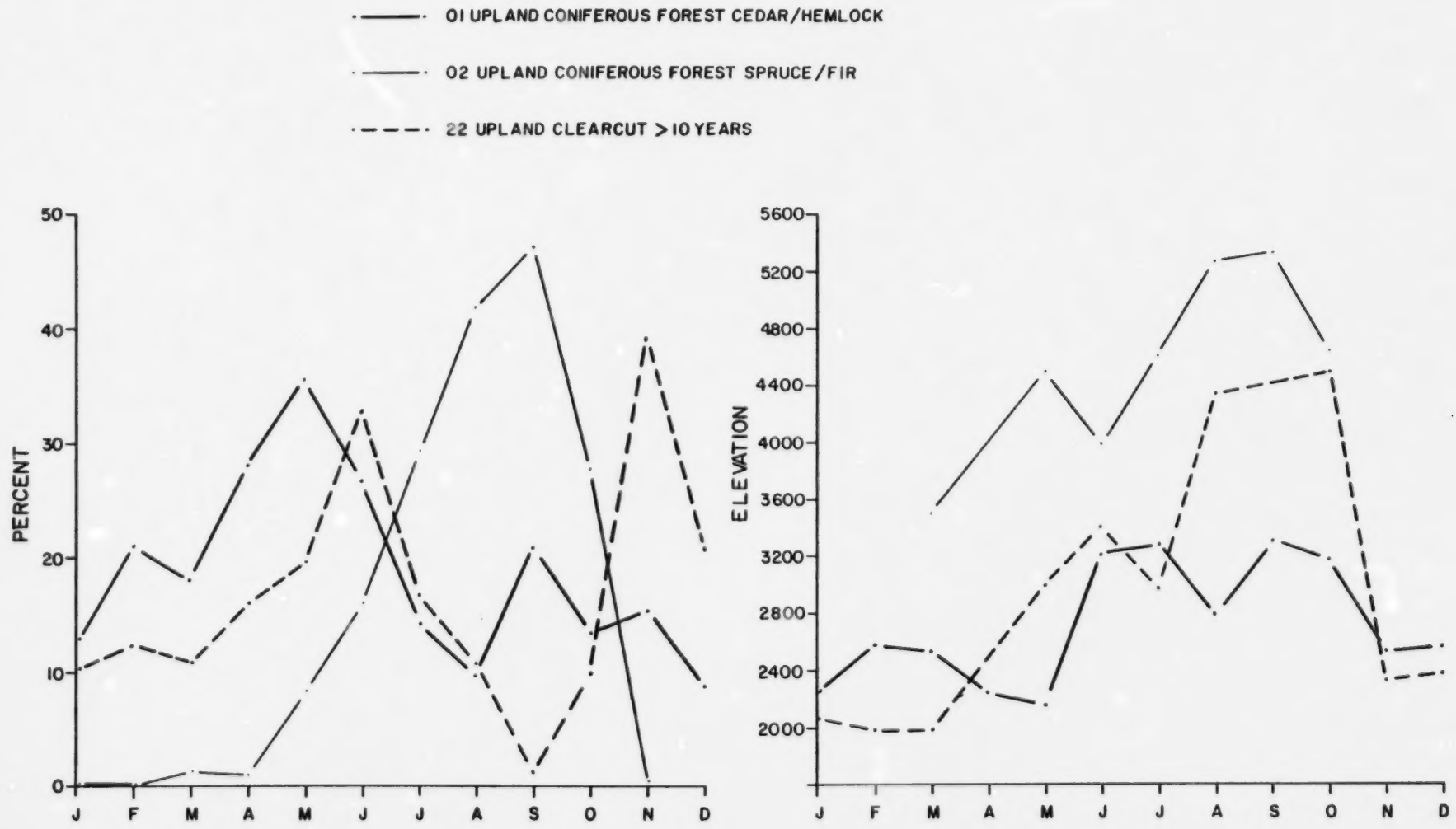
FIGURE 2-12 MONTHLY USE OF THREE HABITAT TYPES (EXPRESSED AS PERCENT OF MONTHLY OBSERVATIONS WITHIN EACH TYPE) AND MONTHLY CHANGES OF ELEVATION WITHIN THESE TYPES



range and tarrying there is evident in "02 Upland Coniferous Forest Spruce/Fir" in a single peak extending from July to October (Fig. 2-12). The winter period seems to be characterized by a wider distribution through a variety of types as no single habitat type dominates the record. The "18 Non-vegetated Riparian Margin" and "20 Riparian Selective Logging" types are the best examples of winter occupation peaks.

Simultaneous with the changes in use of habitat types, there are changes in elevation within types (Fig. 2-12). Two general patterns emerged. If the habitat type occurred through a wide range of elevations there was a gradual summer to fall elevation increase followed by an abrupt early winter decline (Fig. 2-12). Other types, less-frequented and presumably less abundant, totally dropped from the summer records of occupancy. These types probably only occur at the low elevations in areas the moose have generally vacated. Types "12 Upland Mixed Coniferous Forest", "14 Riparian Coniferous Forest", and "17 Riparian Alder/Willow Brush" are examples of this phenomenon. The upland mixed forest which occurs to about 3000 ft a.s.l. drops from use between May and October.

Theoretically, grouping together of similar habitat types should be possible if moose are responding to the characteristics used to create such a grouping. Several groupings of the habitats sampled are logical, e.g. groups based on forest maturity, successional stage, canopy closure, clearing treatment, topographic location, or an overall habitat class.

The simplest grouping is a separation into mature and non-mature types. This is really a subclassification of the successional stage classes and closely approximates canopy closure. The types designated mature did not have the same monthly occupancy (X^2 = 306.0, d.f. = 12, $P < 0.0001$) within the group. The "02 Upland

Coniferous Forest Spruce/Fir" contributed over half of this chi-square value because the highly concentrated use in the July to October period was different from the use of all other types. Comparisons within the non-mature designations were also significant (X^2 = 668.6, d.f. = 64, P < 0.0001). Major contributions to the significant chi-square came from a January selection of "18 Non-vegetated Riparian Margin", a February selection of "12 Immature Upland Mixed Coniferous Forest", a March selection of "17 Riparian Alder/Willow Brush", a selection of "22 Upland Clearcut >10 Years" and avoidance of "20 Riparian Selective Logging >10 Years" in the April to November period; and a selection of "36 Recent burn <25 Years". Therefore, the separation of mature and non-mature types does not appear to be a meaningful distinction for the moose.

A second natural grouping links together habitat types of similar successional stages (Table 2-14). Within the habitat types designated "seral" there is a significant difference in use by month (X^2 = 243.6, d.f. = 24, P < 0.0001). The "17 Riparian Alder/Willow Brush" contributes a large portion of this within-group variation because it is occupied more heavily than expected in later winter whereas other seral types are occupied in proportion to or less than expectation. This observation may relate to the way moose use stream beds as travel corridors when deep snow limits movement (Environment Research Consultants, 1976). An additional major contribution to within-seral variance comes from the lack of occupation of "18 Non-vegetated Riparian Margins" during spring and summer months.

The habitat types designated "Immature" and "<5 years old" were lumped into a "young" successional group because of sample size. These types provided a combined sample of 215 out of the 3268 observations. The variation within-group is significant (X^2 = 41.1, d.f. = 12, P < 0.0001) although the chi-square may not be a

valid test because sparse values result in over 20 percent of the cells having expected counts less than 5. Most of the variation comes from the opposite reactions to "12 Upland Mixed Coniferous Forest" and "41 Upland Mixed Immature Forest". Use of the former type is slightly less than expected all year except February; the latter is used slightly more than expected all year except when it was slightly avoided in February.

The habitat types within the 5 to 10-year successional stage (Table 2-14) are not well represented in the data as they provide only 6.7 percent of the observations; and 82.5 percent of these observations were in "24 Upland Clearcut 5 to 10 Years". The variance within the group is still significant (X^2 = 21.9, d.f. = 4, $P < 0.001$). The light but regular spring to fall use of the above type contrasts the total lack of use during the same period for the other three groups within this group.

The successional grouping which represents fully-developed vegetation combines the types designated "mature" and ">10 Years". Almost half of the contribution to the chi-square for this group comes from the differential use of habitat types in the summer. Analysis of this group closely resembles that of the "Mature" type earlier because of dominance of the "02 Upland Coniferous Forest Spruce/Fir" and "20 Riparian Selective Logging >10 Years" types.

In spite of the differences within each grouping by successional stage, there is also a significant difference between groups (X^2 = 108.0, d.f. = 12, $P < 0.0001$). The "5 to 10-Year" group is used more than expected in January, as is the "Young" group in February. In March, the "seral" types get extra use while the "5 to 10-Year" class receives use less than expected. The use in the spring to fall period and in December seems to closely approximate random expectations.

The degree of closure in the tree canopy is the basis for the third natural grouping. The canopy cover was not measured in all habitat types so a certain degree of conjecture is contained in the classification of types (Table 2-14). Within the closed canopy types, the monthly occupancy is not consistent ($X^2 = 437$, d.f. = 24, $P < 0.0001$). Almost 50 percent of the contribution to this chi-square value comes from the "02 Mature Upland Coniferous Forest - Spruce/Fir". Similarly on a monthly basis, over 50 percent of the variation came from the lumped data for spring and summer months. Once again this variation arises from the apparent seasonal migration to higher altitudes and from the inception of the radio-tracking program which suddenly made the observer aware of moose in the spruce/fir forest. The comparison of use of the closed canopy types and the non-closed types is also significantly different ($X^2 = 146.4$, d.f. = 4, $P < 0.0001$). Use patterns do not match the traditional hypothesis that winter range is composed of dense old-growth closed canopy forest (Pierce and Peck, 1984). In the Revelstoke area, only 37.5 percent of December to February observations were in closed canopy types. Studies in Quebec and New Brunswick have demonstrated that moose gradually moved from the open timber stands to more dense cover (Des Meules 1964, Telfer 1970a) because of snow accumulation in the open. The Revelstoke moose only partially follow this pattern. The closed types were occupied less frequently than expected in December and January and were occupied as expected in February and March. However the relative relationship between expected values and observed values, i.e. the cell chi-square values, declined respectively from 51.2 to 15.6 to 3.9 to 3.4 over this same period. A gradual shift of moose from open into closed types could cause such a decline.

The pattern and extent of logging are known to influence moose populations and feeding habits (de Vos 1962, Telfer 1970b). Twelve of the habitat types recorded in the Revelstoke study are

post-logging habitats harvested by one of two treatments: six clearcut and six selectively cut types. Age of regeneration since harvesting is recorded as three age classes: less than 5 years, 5 to 10 years, and over 10 years. Logged types were also categorized by topographic location into upland and riparian types. Observations were not abundant enough to permit analyses of monthly changes in use of logged types so observations were arbitrarily grouped into winter, spring and fall categories. "Spring" is literally a post-winter period covering the months April to June and "fall" is a pre-winter period from July to October.

The hypothesis that different age moose occupy the three logging treatments (clearcut, selectively cut and uncut) in the same ratio was tested by a contingency table. There is no reason to believe that such occupation differs with logging type (X^2 = 11.1, d.f. = 4, $P > 0.05$). However there was a difference (X^2 = 15.3, d.f. = 4, $P < 0.05$) in how the moose age classes occupied the vegetative age catgories represented by time since logging occurred. Differential use by yearlings appears to be a probable cause of this difference as they contributed over 50 percent to the chi-square value. Yearlings favoured the 5 to 10-year old cuts over both the older and younger cuts. Calves slightly favoured cuts less than 5 years old and adults were evenly distributed through all three ages since cutting. The distribution of moose with regard to topographical location also demonstrated interaction (X^2 = 8.0, d.f. = 2, $P < 0.05$). Calves favoured the logged areas that were riparian as opposed to those that were upland.

The three logging treatments discussed above were not equally used by season (X^2 = 25.7, d.f. = 4, $P < 0.0001$). Surprisingly there was no significant differential use of the logged or unlogged types in winter. Over three-quarters of the chi-square

contribution came from heavy occupation of the unlogged type from July to October. During this same period, both of the logged types were strongly avoided. The necessity of protective cover during hunting season may have caused such a reaction. Seasonal occupancy of the different age cuts also showed significant dependence of each other. Moose did not use the 5 to 10-year old cuts as much as expected during the April to June period, but did the rest of the year. Occupancy was slightly more than expected in July to October for the cuts less than 5 years old. Browse production would be high during this period and desireable browse species would be abundant in the regrowth. The seasonal use of topographic location showed a highly significant difference from the hypothesis of equal use. Almost three-quarters of the contribution to chi-square came from the riparian locations which were used more than expected in the winter and less than expected the rest of the year. Upland locales had the opposite use patterns but to a lesser degree.

SECTION 3.0 - FOOD HABITS

3.1 METHODOLOGY

Moose food habits were examined mainly by use of the feeding site method developed by Cole (1956). Moose were followed along trails in the snow or were observed feeding. Feeding sites were then confined to an arbitrary habitat type that exhibited relatively homogeneous features (Peek et al. 1976). Data were recorded by determining a number of "instances of use" by plant species. An "instance of use" was defined as a single bite within the height range browsed by moose, generally from ground level to approximately 3 m in height. Site features were also recorded, including elevation, slope, aspect, snow depth, and vegetal parameters. The site vegetation was recorded by cover and relative abundance of browse species.

Contents of 32 rumens (Appendix D) of moose killed by hunters, predators, and motor vehicle collisions were analyzed for species composition and plant parts.

3.2 DATA STORAGE

Data collected by trailing moose are filed in the B. C. Hydro system under the file name X.XX.FR1.Y80.MOOSE.FOOD. The format for storage is given in Appendix A.2. Data for rumen analysis are in two files. File X.XX.FR1.RUMEN(WTS) contains data on the plant species (by code) and weights recorded and file X.XX.FR1.MOOSOBS(RUMEN) gives the scientific and common names of plants matched to their code (Appendix A.3). All plant species encountered in the Revelstoke studies are listed in Appendix A.4.

3.3 ANALYSIS DONE

The 32 rumen samples yielded 32 species of plants plus numerous particles identified to Genera or to Family. Decorticated twigs were recorded in 90.3 percent of the samples. The main identifiable food components recorded by the frequency of recurrence (Table 3-1) were Salix spp. (90.6% of the rumen sampled), Taxus brevifolia (68.8%), Thuja plicata (68.8%), Cornus sericea (59.4%), Paxistima myrsinites (53.1%), and Betula papyrifera (53.1%). These percentages are corrected for rumen samples where plant parts of one species were weighed separately. All other species occurred in less than half of the rumen samples.

Of the 40 food components recorded the decorticated stems represented the largest component at 31.6 percent of the total dried weight (Table 3-1). The largest identified component was Salix spp. (12.0%), with Taxus brevifolia at 8.1 percent, Thuja plicata at 7.7 percent, Paxistima myrsinites at 5.9 percent, and Cornus sericea at 5.8 percent. All other species, which were under 5 percent individually by weight, made up 21.1 percent of total rumen contents.

The most commonly eaten Genus was Salix which occurred in 93.8 percent of the rumen sampled. Next in frequency was Cornus in 75.0 percent, then Taxus in 71.9 percent and Thuja in 68.8 percent. Only one rumen contained Carex but in that instance it made up 63.6 percent of the contents by weight.

TABLE 3-1

PERCENTAGE COMPOSITION OF 32 RUMEN SAMPLES
(A percentage of 0.0 equals a trace)

	1	2	3	4	5	6	7	8	9	10	11	12
Unid. Plant Parts	37.5	74.2	28.5	50.6	65.1	21.6	16.3	49.8	15.3	14.3	57.8	50.1
Decorticated Twigs												
ACER GLABRUM	10.6		3.5	2.4								0.2
ACTAEA RUBRA												
ALNUS ICANA					3.2			11.3				
ALNUS VIRIDUS												
ALNUS SPP.												
AMELANCHIER ALNIFOLIA		0.3										
ATHYRIUM FILIX-FEMINA												
BETULA PAPYRIFERA	12.6		9.0		1.3		6.5	2.8		0.0	1.0	24.6
CAREX SPP.												
CORNUS CANADENSIS												
CORNUS SERICEA		1.5	5.5	20.9	4.8	15.8		9.5	0.0		4.8	
CORYLUS CORNUTA		1.6	11.2	0.1		1.7		0.8			21.9	0.9
EPILOBIUM ANGUSTIFOLIUM												
EQUISETUM SPP.											0.0	
HERACLEUM SPHONDYLIUM												
HIERACEUM SPP.												
LOBARIA PULMONARIA		0.1									0.0	0.0
LONICERA INVOLUCRATA												
LONICERA UTAHENSIS									0.0	0.0		
LYSICHTON AMERICANUM												
OPLOPANAX HORRIDUS												
PAXISTIMA MYRSINITES	0.1		0.4	20.4					3.1	2.1		
POACEAE												
POLYPODIACEAE												
POLYTRICHUM SPP.												
POPULUS BALSAMFERA	4.8				2.5		13.8	20.2	0.0		5.8	2.9
POPULUS TREMULOIDES												
PTERIDIUM AQUILINUM												
RHODODENDRON ALBIFLORUM												
RIBES SPP.												
RUBUS IDAEUS												
RUBUS PARVIFLORUS												
SALIX SPP.	11.1	11.0	35.1	3.3	11.4	1.7	1.8	5.1	13.4	4.5	6.0	5.1
SORBUS SITCHENSIS												
SYMPHORICARPOS ALBUS												
TAXUS BREVIFOLIA	16.7	8.9	5.6			0.3	14.6	0.0	67.0	56.3	0.2	1.5
THALICTRUM OCCIDENTALE												
THUJA PLICATA	6.6	2.5	1.2	2.4	11.8	58.9	47.0	0.5	1.2	23.0	2.7	14.7
TIARELLA UNIFOLIATA												
VACCINIUM MEMBRANACEUM												
VACCINIUM SPP.												
VIBURNUM EDULE												
Sample Weight (gm)	957	1846	2119	1720	315	348	1361	2367	1005	1120	2547	2925

IR67.11

RUMEN NUMBER

13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	Ave. By Wt.
	37.4		1.1					28.0				1.8	3.9	2.7						7.8
70.1	13.9	26.0	7.2	27.3	53.8	16.8	43.0	9.3	72.0	23.4	82.1	7.4	31.3	3.6	6.4	27.4	20.1	41.1	31.5	31.6
					5.4	0.6	0.1					1.4					19.7		0.0	1.1
									0.3											0.0
3.9																		0.8		0.9
								0.3							3.0					0.1
	1.0	2.6																		0.1
																				0.0
	19.0	0.1									7.5	12.5		0.2	1.1					1.3
			8.1	46.9	1.1			8.1		6.7		4.3	3.1		27.5				2.3	4.9
												63.6								2.2
	0.3		3.2										1.0		0.0					0.1
4.6			22.7					3.0		18.3		0.9	30.1	7.1	11.1	2.3		23.3	1.1	5.8
				1.5	3.3		2.8							13.9	2.3		1.0	1.1		2.9
								8.6	2.4			0.9		2.7						0.4
																				0.0
																				0.0
									0.7			0.1								0.0
						0.1	1.3													0.0
			12.6													8.2				0.5
					0.3	0.2													0.0	0.0
														15.4		3.3				0.7
												1.6		0.8						0.1
			17.1	0.3		0.4	12.6	2.0		2.9	7.2	0.5	3.5	22.2	30.7	54.7				5.9
														0.1						0.0
	3.4							1.5								1.3				0.2
									0.9			0.8								0.1
		10.7				5.8							1.8	1.8			5.1	4.0		3.1
								16.4												0.2
												1.6								0.1
												0.9								0.0
									0.2											0.0
			13.0								1.0									0.2
								8.3		4.3		1.3		2.2						0.4
	19.3	59.8	15.1	9.8	33.3	22.4	4.1	13.1	3.5	34.8	2.3		20.6	2.8	9.1	2.5	32.7	8.1	38.8	12.0
									18.9	0.3										1.2
										0.2										0.0
				0.3	0.3	8.4	34.9	0.3		6.3		0.1	4.3	24.2	2.4	0.2	21.2	17.8		8.1
									0.2											0.0
11.4				14.0	2.6	45.3	1.3							0.4	6.5		0.2	4.0	26.3	7.7
									0.2			0.4	0.4							0.0
														0.1						0.0
	5.7	0.9						0.3							0.0					0.3
								1.0		2.8										0.1
2065	1693	813	556	337	667	1576	800	397	2506	1452	307	1413	511	1431	1321	1771	889	1342	650	

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APPENDIX A

COMPUTER ENTRY FORMAT FOR MOOSE DATA

APPENDIX A.1

FORMAT FOR WILDLIFE SIGHTINGS

File: X.XX.FR2.MOOSOBS(A) and X.XX.FR1. AERIAL (MOOSE)

Column	Variable	Code Interpretation
1-4	observation number	sequential
5-10	date	day-month-year
11	species	1 - moose 2 - mule deer 3 - white-tailed deer 4 - caribou 5 - grizzly bear 6 - black bear 7 - wolf 8 - coyote 9 - mountain goat
12	group size	1 - 8 actual number 9 more than 8
13	group composition	1 - cow - calf 2 - cow - 2 calf 3 - cow - yearling cow 4 - cow - yearling bull 5 - not known 6 - cow - bull 7 - 2 calves 8 - single calf
14	sex	1 - male 2 - female 3 - unclassified u/c
15	age class	1 - 0+ calf 2 - 1+ yearling 3 - 2+ adult 4 - not known
16	antlers	1 - none 2 - both 3 - right only 4 - left only 5 - not recorded 6 - unknown 7 - velvet

Column	Variable	Code Interpretation
17	right antler points	actual number
18	left antler points	actual number
19-20	collar number	numeric or alphanumeric
21-22	square	UTM grid zone
23-26	longitudinal	determined by "easting"
27-30	latitudinal	determined by "northing"
31	snow depth	0 none 1 1 - 25 2 25 - 50 3 50 - 75 4 75 - 90 5 90 - 100 6 100 - 125 7 125 - 150 8 150+
32	moose sinking	0 none 1 1 - 40 2 40 - 70 3 70 - 90 4 90 - 120 5 120+
33-34	elevation	1 1400 - 1500 2 1500 - 1600 3 1600 - 1700 4 1700 - 1800 5 1800 - 1880 6 1880 - 2000 7 2000 - 2500 8 2500 - 3000 9 3000 - 4000 10 4000 - 5000 11 5000 - 6000 12 6000 - 7000 13 7000 - 8000 14 8000 - 9000 15 9000+

Column	Variable	Code Interpretation
35-37	use of low snow areas (use up to 3)	1 - creek channel 2 - pond or river ice 3 - river margin - drawdown zone 4 - cleared road 5 - old trails made by animals 6 - quamaniq depressions 7 - spring areas 8 - windswept or snowmelt areas on slopes or tops of banks
38	activity	1 - crossing road or on road 2 - swimming 3 - bedded 4 - eating salt on road 5 - foraging on lichens 6 - browsing 7 - foraging 8 - travelling 9 - unclassified
39-40	habitat type	see habitat code
41-44	ecotone	note 2 habitats if animal is within 10 m of a recognizable ecotone
45-47	tracks only	"trk" in first 3 col. of notes
45-80	notes	

HABITAT CODES

01	Mature upland coniferous forest - hemlock/cedar
02	Mature upland coniferous forest - engelmann spruce/subalpine fir
03	Subalpine meadow forest complex
04	Krumholtz
05	Wet subalpine meadow
06	Alpine tundra
07	Alpine cliff - greater than 50 percent exposed rock
08	Subalpine cliff - greater than 50 percent exposed rock
09	Snowfield or glacier
10	Slide, alder dominated
11	Slide, forb dominated
12	Immature upland forest - various species of conifer
13	Immature upland forest - various species of deciduous trees
14	Mature riparian coniferous forest
15	Mature riparian mixed forest
16	Mature riparian deciduous forest
17	Riparian alder/willow association
18	Non-vegetated riparian margin
19	Upland selective logging greater than 10 years
20	Riparian selective logging greater than 10 years
21	Riparian clearcut greater than 10 years
22	Upland clearcut greater than 10 years
23	Riparian clearcut 5 to 10 years
24	Upland clearcut 5 to 10 years
25	Riparian clearcut less than 5 years
26	Upland clearcut less than 5 years
27	Road
28	Road right-of-way/gravel pit area
29	Transmission line right-of-way
30	Non-vegetated cleared area
31	Agricultural land
32	Upland selective logging less than 5 years
33	Not allocated
34	Not allocated
35	Garbage dumps, construction camp
36	Recent burn less than 25 years
37	Spruce/alder/carex, wetland association
38	Sedge meadow
39	Sandbar willow association
40	Pond, creek, river etc.
41	Upland mixed immature forest
42	Upland selective logging 5 to 10 years
43	Riparian selective logging less than 5 years
44	Riparian selective logging 5 to 10 years
45	Reservoir

APPENDIX A.2

FORMAT FOR MOOSE TRAILING DATA

FILE: X.XN.FR1.Y80.MOOSE.FOOD

Column	Variable	Code Interpretation
01-06	date	year (1-2), month (3-4), day (5-6)
07-10	elevation	metres above sea level
11-15	observation number	sequential
16-17	slope	9 percentage classes (see Data Code)
18-19	aspects	9 compass directions (see Data Code)
20-22	snow	
23-38	location	abreviated description
39-49	location	UTM grid as in App. A.1
50-51	overstory canopy	4 percentage classes (see Data Code)
52-53	understory canopy	4 percentage classes (see Data Code)
54-83	overstory characteristics	6 cycles (see Data Code)
2	- species	- tree or shrub species
1	- rank	- 5 density estimate classes
1	- diameter	- 7 classes based on DBH
1	- height	- 4 classes
84-143	understory characteristics	12 cycles as for Col. 54-83

Column	Variable	Code Interpretation
144-146	habitat type	same as App. A.1 types
147-194	use of bark	8 cycles (see Data Code)
2	- species	- tree or shrub species
1	- diameter	- 7 classes
3	- area	- area barked (cm^2)
195-644	browse bites	90 cycles
2	- species	- tree or shrub species
3	- bites	- stems browsed on indiv. plant

SHRUB SPECIES - DATA CODES

Shrub Species

01	Red-Osier Dogwood
02	Willow
03	Black Cottonwood
04	Trembling Aspen
05	Paper Birch
06	California Filbert
07	Western Yew
08	Oregon Boxwood
09	Alpine Fir
10	Sitka Mountain-ash
11	Oval-leaved Blueberry
12	Saskatoon
13	High Bush Cranberry
14	Sitka Mountain Alder
15	Thin-leaved Mountain Alder
16	Rose
17	Western Red Cedar
18	Rocky Mountain Maple
19	Elder
20	Black Hawthorn
21	Western Hemlock
22	White Spruce
23	Tall Oregon Grape
24	Twinberry Honeysuckle
25	Utah Honeysuckle
26	Black Blueberry
27	Hardhack
28	American Bush Cranberry
29	Birch-leaved Spirea
30	Western Thimbleberry
31	Red Raspberry
32	Black Raspberry
33	Cherry
34	Mallow Ninebark
35	Soopolalie
36	Pacific Menziesia
37	Redstem Ceanothus
38	Common Snowberry
39	Rocky Mountain Juniper
40	Engelmann Spruce
41	Western White Pine
42	Lodgepole Pine
43	Douglas Fir
44	Mountain Hemlock
45	White-flowered Rhododendron
46	Glandular Birch
47	Labrador Tea
48	Swamp Kalmia
49	Devil's Club
50	Currant
51	Gooseberry
52	Oceanspray

Slope (percent)

01	<10
02	10 - 20
03	20 - 30
04	30 - 40
05	40 - 50
06	50 - 60
07	60 - 70
08	>70
09	<2 (flat)

Aspect

01	N 0° or 360°
02	NE 45°
03	E 90°
04	SE 135°
05	S 180°
06	SW 225°
07	W 270°
08	NW 315°
09	No Aspect (flat)

Vegetation (percent cover)

01	<25
02	25 - 50
03	50 - 75
04	>75

Diameter Class (cm) (Diameter at breast height)

01	<1
02	1 - 3
03	3 - 5
04	5 - 10
05	10 - 50
06	50 - 100
07	>100

Rank (estimate of spacing between stems)

01	<1 m
02	1 - 3
03	3 - 6
04	6 - 12
05	>12

Height Class

01	<1 m
02	1 - 3 m
03	3 - 10 m
04	>10

FOOD HABITS: DATA SHEET

DATE (DAY, MO., YR.) ELEVATION (M) OBSERVATION NO.

SLOPE ASPECT SNOW DEPTH (CM) MOOSE SINKING (CM)

SNOW CONDITIONS

LOCATION ZONE U – SQUARE – GRID REFERENCE HABITAT TYPE

VEGETATION

CANOPY (TREES)

CANOPY % COVERAGE

UNDERSTORY % COVERAGE

SPECIES	RANK	DBH CLASS	HGT CLASS

UNDERSTORY (SHRUBS)

SPECIES	RANK	DBH CLASS	HGT CLASS

USE OF NON-BROWSE FOODS - BARKING

SPECIES	DBH CLASS	AREA (cm^2)

BROWSE RECORD (RECORD MINIMUM OF 500 'BITES')

SPECIES	BITES

NOTES

APPENDIX A.3

DATA FORMAT FOR ANALYSIS OF RUMEN CONTENTS

Col.	Variable
1-3	Rumen number
4-6	Plant species code
	- 2 digits less than 56 woody vegetation
	- 96 - 99 general classes
	- 3 digits non-woody
7-16	Plant parts eaten
7	- leaves
8	- twigs
9	- buds
10	- catkins
11	- needles
12	- bark
13	- stems
14	- rhizomes
15	- fruit (berries/seedheads)
16	- flowers
17-20	Grams dry weight (x 10), i.e. 1234 = 123.4 g 000 = trace
24-25	Month animal died
26-27	Year animal died
30	M - moose runen
	D - deer rumen

SCIENTIFIC AND COMMON NAMES OF PLANTS
FOUND IN RUMEN CONTENTS

FILE: X.XX.FR1.MOOSOBS (RUMEN)

CONTENTS STATISTICS FOR CONTENTS OF 32 RUMENS
PRINTED BY DESCENDING WEIGHT EATEN

COMMON	LATIN	SUM	N	MEAN	MIN	MAX
DECORTICATED TWIGS	DECORTICATED TWIGS	12981	29	447.621	37	1471
WILLOW	SALIX SPP	4930	38	129.737	0	743
WESTERN YEW	TAXUS BREVIFOLIA	3334	23	144.957	1	673
UNIDENTIFIED PLANTS	UNID. PLANT PARTS	3228	9	358.667	6	1803
WESTERN RED CEDAR	THUJA PLICATA	3177	22	144.409	2	714
OREGON BOXWOOD	PAXISTIMA MYRSINITES	2406	17	141.529	1	969
RED-OSIER DOGWOOD	CORNUS SERICEA	2399	23	104.304	0	359
PAPER BIRCH	BETULA PAPYRIFERA	2010	21	95.714	0	718
BLACK COTTONWOOD	POPULUS BALSAMIFERA TRICH	1265	13	97.308	0	478
HAZELNUT	CORYLUS CORNUTA	1149	15	76.600	2	443
SEDGES	CAREX SPP	898	1	898.000	898	898
COMMON LADY FERN	ATHYRIUM FILIX-FEMINA	540	6	90.000	1	322
SITKA MOUNTAIN ASH	SORBUS SITCHENSIS	479	3	159.667	5	393
THIN-LEAVED MTN ALDER	ALNUS ICANA TENUIFOLIA	368	4	92.000	10	268
DOUGLAS MAPLE	ACER GLABRUM DOUGLASII	364	9	40.444	0	175
AMERICAN SKUNK-CABBAGE	LYSICHTON AMERICANUM	279	2	139.500	58	221
WESTERN THIMBLEBERRY	RUBUS PARVIFLORUS	146	4	36.500	18	63
BLACK TWINBERRY	LONICERA INVOLUCRATA	145	1	145.000	145	145
FIREWEED	EPILOBIUM ANGUSTIFOLIUM	145	5	29.000	6	54
BLUEBERRIES	VACCINIUM SPP	104	4	26.000	0	96
ROCKY MOUNTAIN MAPLE	ACER GLABRUM	101	1	101.000	101	101
FERNS	POLYPODIACEAE	87	3	29.000	6	58
RED RASPBERRY	RUBUS IDAEUS	75	2	37.500	3	72
TWINBERRY HONEYSUCKLE	LONICERA INVOLUCRATA	70	1	70.000	70	70
TREMBLING ASPEN	POPULUS TREMULOIDES	65	1	65.000	65	65
HIGH BUSH CRANBERRY	VIBURNUM EDULE	44	2	22.000	4	40
SITKA MOUNTAIN ALDER	ALNUS VIRIDIS SINUATA	41	2	20.500	1	40
ALDER	ALNUS SPP	38	3	12.667	5	17
DEVIL'S CLUB	OPLOPANAX HORRIDUS	34	2	17.000	11	23
MOSS	POLYTRICHUM SPP	33	2	16.500	11	22
CALIFORNIA FILBERT	CORYLUS CORNUTA	29	1	29.000	29	29
BUNCHBERRY	CORNUS CANADENSIS	28	4	7.000	0	18
WESTERN BRACKEN	PTERIDIUM AQUILINUM	23	1	23.000	23	23
BLACK BLUEBERRY	VACCINIUM MEMBRANACEUM	20	2	10.000	1	19
HAWKWEED	HIERACIUM SPP	18	1	18.000	18	18
UNIFOL-LVD FOAMFLOWER	TIARELLA UNIFOLIATA	14	3	4.667	2	6
LUNGWORT	LOBARIA PULMONARIA	13	5	2.600	0	10
WH-FLOWERD RHODODENDRON	RHODODENDRON ALBIFLORUM	12	2	6.000	0	12
BANEBERRY	ACTAEA RUBRA	7	1	7.000	7	7
SASKATOON	AMELANCHIER ALNIFOLIA	6	1	6.000	6	6
RED TWINBERRY	LONICERA UTAHENSIS	5	4	1.250	0	3
WESTERN MEADOW RUE	THALICTRUM OCCIDENTALE	5	1	5.000	5	5
CURRANT	RIBES SPP	4	1	4.000	4	4
WAXBERRY	SYMPHORICARPOS ALBUS	3	1	3.000	3	3
COMMON COW PARSNIP	HERACLEUM SPHONDYLIUM	2	1	2.000	2	2
GRASSES	POACEAE	1	1	1.000	1	1
HORSETAIL	EQUISETUM SPP	0	1	0.000	0	0
UTAH HONEYSUCKLE	LONICERA UTAHENSIS	0	1	0.000	0	0

BOTANICAL NAMES ALPHABETICAL

OBS	LATIN	COMMON
1	ABIES LASIOCARPA	ALPINE FIR
2	ACER GLABRUM	ROCKY MOUNTAIN MAPLE
3	ACER GLABRUM DOUGLASII	DOUGLAS MAPLE
4	ACTAEA RUBRA	BANEBERRY
5	ALNUS ICANA TENUIFOLIA	THIN-LEAVED MTN ALDER
6	ALNUS SPP	ALDER
7	ALNUS VIRIDIS SINUATA	SITKA MOUNTAIN ALDER
8	AMELANCHIER ALNIFOLIA	SASKATOON
9	ATHYRIUM FILIX-FEMINA	COMMON LADY FERN
10	BETULA GLANDULOSA	GLANDULAR BIRCH
11	BETULA PAPYRIFERA	PAPER BIRCH
12	CEANOTHUS SANGUINEUS	REDSTEM CEANOTHUS
13	CORNUS CANADENSIS	BUNCHBERRY
14	CORNUS SERICEA	RED-OSIER DOGWOOD
15	CORYLUS CORNUTA	CALIFORNIA FILBERT
16	CORYLUS CORNUTA	HAZELNUT
17	CRATAEGUS DOUGLASII	BLACK HAWTHORN
18	EPILOBIUM ANGUSTIFOLIUM	FIREWEED
19	EQUISETUM SPP	HORSETAIL
20	EQUISETUM VARIEGATUM	NORTHERN SCOURING RUSH
21	HERACLEUM SPHONDYLIUM	COMMON COW PARSNIP
22	HIERACIUM SPP	HAWKWEED
23	HOLODISCUS DISCOLOR	OCEAN SPRAY
24	JUNIPERUS SCOPULORUM	ROCKY MOUNTAIN JUNIPER
25	KALMIA MICROPHYLLA	SWAMP KALMIA
26	LEDUM GROENLANDICUM	LABRADOR TEA
27	LINNEA BOREALIS	NORTHERN TWINFLOWER
28	LOBARIA PULMONARIA	LUNGWORT
29	LONICERA INVOLUCRATA	BLACK TWINBERRY
30	LONICERA INVOLUCRATA	TWINBERRY HONEYSUCKLE
31	LONICERA UTAHENSIS	RED TWINBERRY
32	LONICERA UTAHENSIS	UTAH HONEYSUCKLE
33	LYCHOPODIUM SPP	CLUB MOSS
34	LYSICHTON AMERICANUM	AMERICAN SKUNK-CABBAGE
35	MAHONIA AQUIFOLIUM	TALL OREGON GRAPE
36	MENZIESIA FERRUGINEA	PACIFIC MENZIESIA
37	OPLOPANAX HORRIDUS	DEVIL'S CLUB
38	PAXISTIMA MYRSINITES	OREGON BOXWOOD
39	PHYSOCARPUS MALVACEUS	MALLOW NINEBARK
40	PICEA ENGELMANNII	ENGELMANN SPRUCE
41	PICEA GLAUCA	WHITE SPRUCE
42	PINUS CONTORTA	LODGEPOLE PINE
43	PINUS MONTICOLA	WESTERN WHITE PINE
44	POACEAE	GRASSES
45	POLYPODIACEAE	FERNS
46	POLYTRICHUM SPP	MOSS
47	POPULUS BALSAMIFERA TRICH	BLACK COTTONWOOD
48	POPULUS TREMULOIDES	TREMBLING ASPEN
49	PRUNUS SPP	CHERRY
50	PSEUDOTSUGA MENZIESII	DOUGLAS FIR
51	PTERIDIUM AQUILINUM	WESTERN BRACKEN
52	RHODODENDRON ALBIFLORUM	WH-FLOWERD RHODODENDRON
53	RIBES SPP	CURRANT
54	RIBES SPP	GOOSEBERRY
55	ROSA SPP	ROSE

BOTANICAL NAMES ALPHABETICAL

OBS	LATIN	COMMON
56	RUBUS IDAEUS	RED RASPBERRY
57	RUBUS LEUCODERMIS	BLACK RASPBERRY
58	RUBUS PARVIFLORUS	WESTERN THIMBLEBERRY
59	SALIX SPP	WILLOW
60	SAMBUCUS RECEMOSA	AMERICAN ELDER
61	SHEPHERDIA CANADENSIS	SOOPOLALIE
62	SORBUS SITCHENSIS	SITKA MOUNTAIN ASH
63	SPIRAEA BETUFOLIA	BIRCH-LEAVED SPIREA
64	SPIRAEA DOUGLASII	HARDHACK
65	SYMPHORICARPOS ALBUS	COMMON SNOWBERRY
66	SYMPHORICARPOS ALBUS	WAXBERRY
67	TAXUS BREVIFOLIA	WESTERN YEW
68	THALICTRUM OCCIDENTALE	WESTERN MEADOW RUE
69	THUJA PLICATA	WESTERN RED CEDAR
70	TRIFOLIUM SPP	CLOVER
71	TSUGA HETEROPHYLLA	WESTERN HEMLOCK
72	TSUGA MERTENSIANA	MOUNTAIN HEMLOCK
73	VACCINIUM MEMBRANACEUM	BLACK BLUEBERRY
74	VACCINIUM OVALIFOLIUM	OVAL-LEAVED BLUEBERRY
75	VACCINIUM SPP	BLUEBERRIES
76	VIBURNUM EDULE	HIGH BUSH CRANBERRY
77	VIBURNUM OPULUS TRILOBUM	AMERICAN BUSH CRANBERRY

OBS	COMMON	LATIN
1	ALDER	ALNUS SPP
2	ALPINE FIR	ABIES LASIOCARPA
3	AMERICAN BUSH CRANBERRY	VIBURNUN OPULUS TRILOBUM
4	AMERICAN ELDER	SAMBUCUS RECEMOSA
5	AMERICAN SKUNK-CABBAGE	LYSICHTON AMERICANUM
6	BANEBERRY	ACTAEA RUBRA
7	BIRCH-LEAVED SPIREA	SPIRAEA BETUFOLIA
8	BLACK BLUEBERRY	VACCINIUM MEMBRANACEUM
9	BLACK COTTONWOOD	POPULUS BALSAMIFERA TRICH
10	BLACK HAWTHORN	CRATAEGUS DOUGLASII
11	BLACK RASPBERRY	RUBUS LEUCODERMIS
12	BLACK TWINBERRY	LONICERA INVOLUCRATA
13	BLUEBERRIES	VACCINIUM SPP
14	BUNCHBERRY	CORNUS CANADENSIS
15	CALIFORNIA FILBERT	CORYLUS CORNUTA
16	CHERRY	PRUNUS SPP
17	CLOVER	TRIFOLIUM SPP
18	CLUB MOSS	LYCHOPODIUM SPP
19	COMMON COW PARSNIP	HERACLEUM SPHONDYLIUM
20	COMMON LADY FERN	ATHYRIUM FILIX-FEMINA
21	COMMON SNOWBERRY	SYMPHORICARPOS ALBUS
22	CURRANT	RIBES SPP
23	DEVIL'S CLUB	OPLOPANAX HORRIDUS
24	DOUGLAS FIR	PSEUDOTSUGA MENZIESII
25	DOUGLAS MAPLE	ACER GLABRUM DOUGLASII
26	ENGELMANN SPRUCE	PICEA ENGELMANNII
27	FERNS	POLYPODIACEAE
28	FIREWEED	EPILOBIUM ANGUSTIFOLIUM
29	GLANDULAR BIRCH	BETULA GLANDULOSA
30	GOOSEBERRY	RIBES SPP
31	GRASSES	POACEAE
32	HARDHACK	SPIRAEA DOUGLASII
33	HAWKWEED	HIERACIUM SPP
34	HAZELNUT	CORYLUS CORNUTA
35	HIGH BUSH CRANBERRY	VIBURNUM EDULE
36	HORSETAIL	EQUISETUM SPP
37	LABRADOR TEA	LEDUM GROENLANDICUM
38	LODGEPOLE PINE	PINUS CONTORTA
39	LUNGWORT	LOBARIA PULMONARIA
40	MALLOW NINEBARK	PHYSOCARPUS MALVACEUS
41	MOSS	POLYTRICHUM SPP
42	MOUNTAIN HEMLOCK	TSUGA MERTENSIANA
43	NORTHERN SCOURING RUSH	EQUISETUM VARIEGATUM
44	NORTHERN TWINFLOWER	LINNEA BOREALIS
45	OCEAN SPRAY	HOLODISCUS DISCOLOR
46	OREGON BOXWOOD	PAXISTIMA MYRSINITES
47	OVAL-LEAVED BLUEBERRY	VACCINIUM OVALIFOLIUM
48	PACIFIC MENZIESIA	MENZIESIA FERRUGINEA
49	PAPER BIRCH	BETULA PAPYRIFERA
50	RED RASPBERRY	RUBUS IDAEUS
51	RED TWINBERRY	LONICERA UTAHENSIS
52	RED-OSIER DOGWOOD	CORNUS SERICEA
53	REDSTEM CEANOTHUS	CEANOTHUS SANGUINEUS
54	ROCKY MOUNTAIN JUNIPER	JUNIPERUS SCOPULORUM
55	ROCKY MOUNTAIN MAPLE	ACER GLABRUM

OBS	COMMON	LATIN
56	ROSE	ROSA SPP
57	SASKATOON	AMELANCHIER ALNIFOLIA
58	SITKA MOUNTAIN ALDER	ALNUS VIRIDIS SINUATA
59	SITKA MOUNTAIN ASH	SORBUS SITCHENSIS
60	SOOPOLALIE	SHEPHERDIA CANADENSIS
61	SWAMP KALMIA	KALMIA MICROPHYLLA
62	TALL OREGON GRAPE	MAHONIA AQUIFOLIUM
63	THIN-LEAVED MTN ALDER	ALNUS ICANA TENUIFOLIA
64	TREMBLING ASPEN	POPULUS TREMULOIDES
65	TWINBERRY HONEYSUCKLE	LONICERA INVOLUCRATA
66	UTAH HONEYSUCKLE	LONICERA UTAHENSIS
67	WAXBERRY	SYMPHORICARPOS ALBUS
68	WESTERN BRACKEN	PTERIDIUM AQUILINUM
69	WESTERN HEMLOCK	TSUGA HETEROPHYLLA
70	WESTERN MEADOW RUE	THALICTRUM OCCIDENTALE
71	WESTERN RED CEDAR	THUJA PLICATA
72	WESTERN THIMBLEBERRY	RUBUS PARVIFLORUS
73	WESTERN WHITE PINE	PINUS MONTICOLA
74	WESTERN YEW	TAXUS BREVIFOLIA
75	WH-FLOWERD RHODODENDRON	RHODODENDRON ALBIFLORUM
76	WHITE SPRUCE	PICEA GLAUCA
77	WILLOW	SALIX SPP

APPENDIX B

AVAILABILITY, STORAGE FORMAT, VOLUME AND POSSIBLE ANALYSIS FOR MOOSE DATA

APPENDIX B

AVAILABILITY, STORAGE FORMAT, VOLUME
AND POSSIBLE ANALYSIS FOR MOOSE DATA

B.1 HUNTER SAMPLE RESULTS

Format: B.C. Fish and Wildlife hunter questionnaire kill results for 1976 to 1981 are on file. Four years of these data are in disk data sets:

X.XK.FF1.FWILD76
X.XK.FF1.FWILD77
X.XK.FF1.FWILD78
X.XK.FF1.FWILD79

There is also a hard copy print of these file. Data for 1980 and 1981 have been obtained from the Branch on magnetic tape. Unfortunately the Branch altered data storage format such that the program written to dump the above 4 years onto the Hydro system no longer functions.

Records of known hunter kills in Revelstoke area for 1977 to 1984 in notebooks.

Volume: 25 to 30 moose bulls shot per year.

Possible Analyses: Total numbers, distribution of kill, mortality data for moose population.

B.2 UTILIZATION TRANSECTS

Format: Utilization transects to describe relative use of different habitats and vegetal structure were conducted in 1978 and 1979. Data were entered onto computer (data sets X.XN.FR1.Y80.MOOSE.UTIL78 and X.XN.FR1.Y80.MOOSE.UTIL79).

Volume: Total of 66 variables at each of 864 stations on 83 transects and 4 study areas.

Possible Analyses:

1. Information can be compared with food habits, distribution, telemetry, snow relationships and other study aspects to cross-reference data sets.

2. Need plant biomass regression equations to convert number of twigs eaten or grown to biomass figures.

B.3 SIGHTING RECORDS

Format: Maps, air photos, ortho photos showing locations, computer listings with UTM map grid locations, notebooks, air photos, photo files - at least six different data formats. Computer data stored in file X.XX.FR1.MOOSOBS(A) and X.XX.FR1.AERIAL(MOOSE) under the format shown in Appendix A.1.

Volume: A total of moose observations - mostly winter data; all entered into computer listings and edited; but only some mapped.

Possible Analyses:

1. Analysis will show age/sex ratios, group size and composition, mortality, survival, winter and summer distribution, habitat use, snow relationships, population size and changes and general moose ecology.

2. Data were collected with a view to constructing a model of the moose population that could be used to predict future population changes.

B.4 POPULATION SIZE AND CHANGES

- Data were derived from aerial flights (1977 to 1985) which are part of the sightings records.

- 1980 to 1984 data may be suitable for mark-recapture using collared moose and bulls (with distinctive antlers in early winter) as marked members of the population.

- Periodic "total count" flights were conducted after fresh snowfall - maximum count 150 moose. Nothing in the data designates which flights these are.

B.5 TAGGING

Format: Tagging data for about 35 animals + 10 from B.C. Fish and Wildlife study - some data summarized into notes but others still in raw form. Fish and Wildlife data not available yet.

Volume: 85 moose.

Analysis: Use data to show morphology, drug reaction, home range and movements of collared animals, range fidelity, survival and mortality rates, reproduction, and population size through mark-recapture method mentioned previously.

B.6 TELEMETRY

Format: Air photo and ortho photo locations, photos for some of the sightings. Computer listings for all radio locations for 16 moose in the sightings records.

Volume: There are 1018 radio or collar locations for moose mainly since the fall of 1983; additional data for 4 years previously for four moose that were collared as part of the Fish and Wildlife Branch telemetry study. Fish and Wildlife Branch data still have not been reported and are not yet available for comparison.

Analysis:

1. Data can be used to calculate home range, movements, habitat utilization, calving/rutting areas and times, distribution, reservoir crossing frequency, mortality, survival, social interactions etc. All relate to impact of clearing and flooding and back to other aspects of moose study.

2. Air photos, notes, photos have to be cross-referenced and used to update computer listings - locations need to be mapped by computer (ongoing photogrammetry work) and then computer listings finalized before any other analysis is done.

B.7 FOOD HABITS

Format:

- 250 000 bites recorded by trailing moose in winter. Stored in data file X.XN.Y80.ORG.MOOSE.FOOD which is formatted in Appendix A.2.

- 32 moose rumen samples analyzed for plant species composition by weight and for plant parts utilized. Data stored in file X.XX.FR1.RUMEN(WTS).

- 12 500 browsed twigs were sampled in the utilization transect program.

- fecal samples (approximately 700 groups) collected and saved since 1982 - dry samples held by R. Bonar for microscopic determination of food habits.

Volume: As above.

Possible Analyses:

1. Trailing data has been entered on the computer to analyze food habits by month and habitat type. Compare results to other methods and habitat utilization data from other aspects (telemetry - utilization transects, etc.).

2. Note and describe changes in food habits related to flooding, snow accumulation and density, etc.

3. Need plant biomass equations to convert "bites" to dry matter by weight.

B.8 GENERAL ECOLOGY

Format: Miscellaneous observations on various aspects of general ecology including antler development and shedding, bedding practices, dispersal, fetal and birth rates, roadkills, heat stress avoidance, predator avoidance, etc.

Volume: Several hundred notes.

Analysis: Collate and report with other program aspects.

B.9 SNOW WEATHER RELATIONSHIPS

Format:

- Weather records from Revelstoke Airport, Revelstoke damsite, Downie Slide, 50 mile Highways camp and Mica Creek are available. Snow depth data are stored in the B.C. Hydro computer system on two files: X.XX.FFC.SNOW(STATIONS) contains data on snow station names, locations, and forest canopy types; and X.XX.FFC.SNOW(SNOWDETH) contains depth information for the 27 stations.

- Snow depth estimates for all visual sightings, telemetry locations, trailing etc.

Volume: 12 000 to 15 000 records.

Possible Analyses:

1. Obtain and computerize weather and snow depth data. Compare winter severity to observed moose population trends, habitat use, movements, etc. - include winter severity in population model.

2. Examine moose population response to severe winters before and after flooding (haven't had a severe one post-impoundment yet) - this will probably be the main reservoir impact on moose - survival may decrease because of habitat loss and increased snow depths on remaining area.

APPENDIX C

COLLARING DATA INCLUDING KNOWN DEATHS AND DATES LAST SEEN

APPENDIX C

COLLARING DATA INCLUDING KNOWN DEATHS AND DATES LAST SEEN

MOOSE

Collar	Date Marked	Died	Last Seen
BL	84/01/06		85/02/06
BR	83/12/16		85/02/06
C8	82/02/23	84/07/16	
DA	84/11/15		85/02/06
DK	84/01/06	84/09/18	
ED	83/01/11	84/10/03	
FR	84/02/10		85/02/06
GR	84/11/06		85/01/15
GS	79/11/28		85/02/06
LU	84/01/03		85/02/06
MI	80/01/18		85/02/06
MK	84/01/16	84/01/23	
NR	82/12/30		
OY	82/01/05		
RH	79/01/24		
	83/12/19	84/04/11	
SC	82/12/10		84/01/18
TE	80/03/11		82/03/11
WE	84/01/20		85/02/06
01	81/03/09		83/02/10
02	81/03/09		83/02/16
03	81/03/09		83/03/02
04	81/03/09		83/02/10
05	81/03/12		83/02/02
06	81/03/12		83/02/10
07	81/03/12		83/03/04

Collar	Date Marked	Died	Last Seen
08	81/03/12	81/03/12	
09	83/02/10		83/02/16
10	81/12/15		84/11/20
11	82/01/12	85/01/15	
12	82/01/12		84/02/03
13	82/02/24		82/03/10
14	82/01/12		83/02/10
15	82/01/13		82/01/13
16	82/01/18		82/03/02
17	82/01/15		83/03/01
18	82/01/20		82/03/11
19	82/01/20		82/01/20
20	82/01/26		82/01/26
21	82/01/20		83/02/10
22	82/01/25		82/01/25
23	82/01/26		84/03/13
24	82/01/26		82/01/26
25	82/01/25		83/03/04
26	82/02/23		83/03/04
27	83/02/16		83/02/16
28	83/02/16		83/02/16
29	83/03/01		84/10/07
30	83/02/16		84/03/16
31	83/03/01		85/02/06
32	83/03/02		83/03/02
33	83/03/02		83/03/02
34	83/03/01		83/03/01
35	83/03/02		83/03/02
36	83/03/02		83/03/02

APPENDIX D

CONTENTS BY SPECIES AND PLANT PARTS OF 32 RUMEN SAMPLES

RUMEN CONTENTS GIVING SPECIES, PART EATEN, AND WEIGHT
(FOR PLANT PARTS 1= PRESENT AND .= ABSENT)

RUMEN=1 MONYR=279

OBS	SPECIES CODE	BOTANICAL NAME	COMMON NAME	WEIGHT	TWIG	LEAF	BUD	RHIZME	STEM
1	99	DECORTICATED TWIGS	DECORTICATED TWIGS	359	1	.	.	.	.
2	7	TAXUS BREVIFOLIA	WESTERN YEW	160	1	.	.	.	1
3	5	BETULA PAPYRIFERA	PAPER BIRCH	121	1	.	1	1	.
4	2	SALIX SPP	WILLOW	106	1	.	1	.	.
5	18	ACER GLABRUM	ROCKY MOUNTAIN MAPLE	101	1	.	1	.	.
6	17	THUJA PLICATA	WESTERN RED CEDAR	63	.	1	.	.	.
7	3	POPULUS BALSAMIFERA TRICH	BLACK COTTONWOOD	46	1	.	1	.	.
8	8	PAXISTIMA MYRSINITES	OREGON BOXWOOD	1	.	1	.	.	.

RUMEN=2 MONYR=1079

OBS	SPECIES CODE	BOTANICAL NAME	COMMON NAME	WEIGHT	TWIG	LEAF	BUD	RHIZME	STEM
9	99	DECORTICATED TWIGS	DECORTICATED TWIGS	1369	1	.	.	.	.
10	2	SALIX SPP	WILLOW	173	1	.	1	.	.
11	7	TAXUS BREVIFOLIA	WESTERN YEW	165	1	.	.	.	1
12	17	THUJA PLICATA	WESTERN RED CEDAR	46	1	1	.	.	.
13	2	SALIX SPP	WILLOW	30	.	.	.	.	.
14	6	CORYLUS CORNUTA	CALIFORNIA FILBERT	29	1	.	1	1	.
15	1	CORNUS SERICEA	RED-OSIER DOGWOOD	27	1	.	.	.	.
16	12	AMELANCHIER ALNIFOLIA	SASKATOON	6	1	.	.	.	.
17	53	LOBARIA PULMONARIA	LUNGWORT	1	.	1	.	.	.

RUMEN=3 MONYR=280

OBS	SPECIES CODE	BOTANICAL NAME	COMMON NAME	WEIGHT	TWIG	LEAF	BUD	RHIZME	STEM
18	2	SALIX SPP	WILLOW	743	1	.	1	1	.
19	99	DECORTICATED TWIGS	DECORTICATED TWIGS	603	1	.	.	.	.
20	6	CORYLUS CORNUTA	HAZELNUT	238	1	.	1	1	.
21	5	BETULA PAPYRIFERA	PAPER BIRCH	191	1	.	1	.	.
22	7	TAXUS BREVIFOLIA	WESTERN YEW	118	1	.	.	.	1
23	1	CORNUS SERICEA	RED-OSIER DOGWOOD	117	1	.	1	.	.
24	18	ACER GLABRUM DOUGLASII	DOUGLAS MAPLE	75	1	.	1	.	.
25	17	THUJA PLICATA	WESTERN RED CEDAR	25	1	1	.	.	.
26	8	PAXISTIMA MYRSINITES	OREGON BOXWOOD	9	1	1	.	.	.

RUMEN CONTENTS GIVING SPECIES, PART EATEN, AND WEIGHT
(FOR PLANT PARTS 1= PRESENT AND .= ABSENT)

RUMEN=4 MONYR=281

OBS	SPECIES CODE	BOTANICAL NAME	COMMON NAME	WEIGHT	TWIG	LEAF	BUD	RHIZME	STEM
27	99	DECORTICATED TWIGS	DECORTICATED TWIGS	870	.	.	.	.	.
28	1	CORNUS SERICEA	RED-OSIER DOGWOOD	359	.	.	.	.	.
29	8	PAXISTIMA MYRSINITES	OREGON BOXWOOD	351	.	.	.	.	.
30	2	SALIX SPP	WILLOW	56	.	.	.	.	.
31	17	THUJA PLICATA	WESTERN RED CEDAR	41	.	.	.	.	.
32	18	ACER GLABRUM DOUGLASII	DOUGLAS MAPLE	41	.	.	.	.	.
33	6	CORYLUS CORNUTA	HAZELNUT	2	.	.	.	.	.

RUMEN=5 MONYR=381

OBS	SPECIES CODE	BOTANICAL NAME	COMMON NAME	WEIGHT	TWIG	LEAF	BUD	RHIZME	STEM
34	99	DECORTICATED TWIGS	DECORTICATED TWIGS	205	1	.	.	.	.
35	17	THUJA PLICATA	WESTERN RED CEDAR	37	.	.	.	.	1
36	2	SALIX SPP	WILLOW	36	1	.	.	.	.
37	1	CORNUS SERICEA	RED-OSIER DOGWOOD	15	1	.	.	.	.
38	15	ALNUS ICANA TENUIFOLIA	THIN-LEAVED MTN ALDER	10	1	.	.	.	.
39	3	POPULUS BALSAMIFERA TRICH	BLACK COTTONWOOD	8	1	.	.	.	.
40	5	BETULA PAPYRIFERA	PAPER BIRCH	4	1	.	.	.	.

RUMEN=6 MONYR=182

OBS	SPECIES CODE	BOTANICAL NAME	COMMON NAME	WEIGHT	TWIG	LEAF	BUD	RHIZME	STEM
41	17	THUJA PLICATA	WESTERN RED CEDAR	205	.	.	.	.	.
42	99	DECORTICATED TWIGS	DECORTICATED TWIGS	75	.	.	.	.	.
43	1	CORNUS SERICEA	RED-OSIER DOGWOOD	55	.	.	.	.	.
44	2	SALIX SPP	WILLOW	6	.	.	.	.	.
45	6	CORYLUS CORNUTA	HAZELNUT	6	.	.	.	.	.
46	7	TAXUS BREVIFOLIA	WESTERN YEW	1	.	.	.	.	.

RUMEN=7 MONYR=182

OBS	SPECIES CODE	BOTANICAL NAME	COMMON NAME	WEIGHT	TWIG	LEAF	BUD	RHIZME	STEM
47	17	THUJA PLICATA	WESTERN RED CEDAR	639	.	.	.	.	.
48	99	DECORTICATED TWIGS	DECORTICATED TWIGS	222	.	.	.	.	.
49	7	TAXUS BREVIFOLIA	WESTERN YEW	109	.	.	.	.	.
50	3	POPULUS BALSAMIFERA TRICH	BLACK COTTONWOOD	188	.	.	.	.	.
51	5	BETULA PAPYRIFERA	PAPER BIRCH	89	.	.	.	.	.
52	2	SALIX SPP	WILLOW	24	.	.	.	.	.

RUMEN CONTENTS GIVING SPECIES, PART EATEN, AND WEIGHT
(FOR PLANT PARTS 1= PRESENT AND .= ABSENT)

RUMEN=8 MONYR=282

OBS	SPECIES CODE	BOTANICAL NAME	COMMON NAME	WEIGHT	TWIG	LEAF	BUD	RHIZME	STEM
53	99	DECORTICATED TWIGS	DECORTICATED TWIGS	1178	.	.	.	.	.
54	3	POPULUS BALSAMIFERA TRICH	BLACK COTTONWOOD	478	.	.	.	.	.
55	15	ALNUS ICANA TENUIFOLIA	THIN-LEAVED MTN ALDER	268	.	.	.	.	.
56	1	CORNUS SERICEA	RED-OSIER DOGWOOD	224	.	.	.	.	.
57	2	SALIX SPP	WILLOW	120	.	.	.	.	.
58	5	BETULA PAPYRIFERA	PAPER BIRCH	67	.	.	.	.	.
59	6	CORYLUS CORNUTA	HAZELNUT	19	.	.	.	.	.
60	17	THUJA PLICATA	WESTERN RED CEDAR	12	.	.	.	.	.
61	7	TAXUS BREVIFOLIA	WESTERN YEW	1	.	.	.	.	.

RUMEN=9 MONYR=1282

OBS	SPECIES CODE	BOTANICAL NAME	COMMON NAME	WEIGHT	TWIG	LEAF	BUD	RHIZME	STEM
62	7	TAXUS BREVIFOLIA	WESTERN YEW	673	.	.	.	.	.
63	99	DECORTICATED TWIGS	DECORTICATED TWIGS	154	.	.	.	.	.
64	2	SALIX SPP	WILLOW	135	.	.	.	.	.
65	8	PAXISTIMA MYRSINITES	OREGON BOXWOOD	31	.	.	.	.	.
66	17	THUJA PLICATA	WESTERN RED CEDAR	12	.	.	.	.	.
67	1	CORNUS SERICEA	RED-OSIER DOGWOOD	0	.	.	.	.	.
68	3	POPULUS BALSAMIFERA TRICH	BLACK COTTONWOOD	0	.	.	.	.	.
69	25	LONICERA UTAHENSIS	UTAH HONEYSUCKLE	0	.	.	.	.	.

RUMEN=10 MONYR=1282

OBS	SPECIES CODE	BOTANICAL NAME	COMMON NAME	WEIGHT	TWIG	LEAF	BUD	RHIZME	STEM
70	7	TAXUS BREVIFOLIA	WESTERN YEW	630	.	.	.	.	.
71	17	THUJA PLICATA	WESTERN RED CEDAR	257	.	.	.	.	.
72	99	DECORTICATED TWIGS	DECORTICATED TWIGS	160	.	.	.	.	.
73	2	SALIX SPP	WILLOW	50	.	.	.	.	.
74	8	PAXISTIMA MYRSINITES	OREGON BOXWOOD	23	.	.	.	.	.
75	5	BETULA PAPYRIFERA	PAPER BIRCH	0	.	.	.	.	.
76	25	LONICERA UTAHENSIS	RED TWINBERRY	0	.	.	.	.	.

RUMEN=11 MONYR=183

OBS	SPECIES CODE	BOTANICAL NAME	COMMON NAME	WEIGHT	TWIG	LEAF	BUD	RHIZME	STEM
77	99	DECORTICATED TWIGS	DECORTICATED TWIGS	1471	.	.	.	.	.
78	6	CORYLUS CORNUTA	HAZELNUT	443	1	.	.	.	.
79	2	SALIX SPP	WILLOW	152	1	.	1	.	.
80	3	POPULUS BALSAMIFERA TRICH	BLACK COTTONWOOD	147	1	.	1	.	.
81	1	CORNUS SERICEA	RED-OSIER DOGWOOD	122	1	.	.	.	.
82	6	CORYLUS CORNUTA	HAZELNUT	114	.	.	.	1	.
83	17	THUJA PLICATA	WESTERN RED CEDAR	68	.	1	.	.	.

RUMEN CONTENTS GIVING SPECIES, PART EATEN, AND WEIGHT
(FOR PLANT PARTS 1= PRESENT AND .= ABSENT)

RUMEN=11 MONYR=183

OBS	SPECIES CODE	BOTANICAL NAME	COMMON NAME	WEIGHT	TWIG	LEAF	BUD	RHIZME	STEM
84	5	BETULA PAPYRIFERA	PAPER BIRCH	26	1	.	.	.	.
85	7	TAXUS BREVIFOLIA	WESTERN YEW	4	1	.	.	.	1
86	2	SALIX SPP	WILLOW	0	.	1	.	.	.
87	53	LOBARIA PULMONARIA	LUNGWORT	0	.	1	.	.	.
88	504	EQUISETUM SPP	HORSETAIL	0	.	.	.	.	.

RUMEN=12 MONYR=183

OBS	SPECIES CODE	BOTANICAL NAME	COMMON NAME	WEIGHT	TWIG	LEAF	BUD	RHIZME	STEM
89	99	DECORTICATED TWIGS	DECORTICATED TWIGS	1464	1	.	.	.	.
90	5	BETULA PAPYRIFERA	PAPER BIRCH	718	1	.	1	.	.
91	17	THUJA PLICATA	WESTERN RED CEDAR	430	1	1	.	.	.
92	2	SALIX SPP	WILLOW	150	1	.	1	.	.
93	3	POPULUS BALSAMIFERA TRICH	BLACK COTTONWOOD	86	1	.	1	.	.
94	7	TAXUS BREVIFOLIA	WESTERN YEW	45	1	.	.	.	1
95	6	CORYLUS CORNUTA	HAZELNUT	26	1	.	1	1	.
96	18	ACER GLABRUM DOUGLASII	DOUGLAS MAPLE	6	1	.	1	.	.
97	53	LOBARIA PULMONARIA	LUNGWORT	0	.	1	.	.	.

RUMEN=13 MONYR=183

OBS	SPECIES CODE	BOTANICAL NAME	COMMON NAME	WEIGHT	TWIG	LEAF	BUD	RHIZME	STEM
98	99	DECORTICATED TWIGS	DECORTICATED TWIGS	1447	1	.	.	.	.
99	1	CORNUS SERICEA	RED-OSIER DOGWOOD	302	.	.	.	.	.
100	17	THUJA PLICATA	WESTERN RED CEDAR	236	.	.	.	.	.
101	15	ALNUS ICANA TENUIFOLIA	THIN-LEAVED MTN ALDER	80	.	.	.	.	.

RUMEN=14 MONYR=1083

OBS	SPECIES CODE	BOTANICAL NAME	COMMON NAME	WEIGHT	TWIG	LEAF	BUD	RHIZME	STEM
102	98	UNID. PLANT PARTS	UNIDENTIFIED PLANTS	634	1	.	1	.	.
103	301	ATHYRIUM FILIX-FEMINA	COMMON LADY FERN	322	.	.	.	.	.
104	2	SALIX SPP	WILLOW	273	1	.	1	.	.
105	99	DECORTICATED TWIGS	DECORTICATED TWIGS	235	1	.	.	.	.
106	508	VACCINIUM SPP	BLUEBERRIES	96	1	.	.	.	.
107	55	POLYPODIACEAE	FERNS	58	.	1	.	.	.
108	2	SALIX SPP	WILLOW	53	.	1	.	.	.
109	507	ALNUS SPP	ALDER	17	1	.	1	1	.
110	347	CORNUS CANADENSIS	BUNCHBERRY	5	.	1	1	.	.

RUMEN CONTENTS GIVING SPECIES, PART EATEN, AND WEIGHT
(FOR PLANT PARTS 1= PRESENT AND .= ABSENT)

RUMEN=15 MONYR=1083

OBS	SPECIES CODE	BOTANICAL NAME	COMMON NAME	WEIGHT	TWIG	LEAF	BUD	RHIZME	STEM
111	2	SALIX SPP	WILLOW	395	1	.	1	.	.
112	99	DECORTICATED TWIGS	DECORTICATED TWIGS	211	1	.	.	.	.
113	2	SALIX SPP	WILLOW	91	.	1	.	.	.
114	3	POPULUS BALSAMIFERA TRICH	BLACK COTTONWOOD	87	1	.	.	.	.
115	507	ALNUS SPP	ALDER	16	.	1	.	.	.
116	508	VACCINIUM SPP	BLUEBERRIES	7	1	.	.	.	.
117	507	ALNUS SPP	ALDER	5	1	.	.	.	.
118	301	ATHYRIUM FILIX-FEMINA	COMMON LADY FERN	1	.	.	.	.	.

RUMEN=16 MONYR=1083

OBS	SPECIES CODE	BOTANICAL NAME	COMMON NAME	WEIGHT	TWIG	LEAF	BUD	RHIZME	STEM
119	1	CORNUS SERICEA	RED-OSIER DOGWOOD	126	1	.	1	.	.
120	8	PAXISTIMA MYRSINITES	OREGON BOXWOOD	95	1	1	.	.	.
121	2	SALIX SPP	WILLOW	84	1	.	1	.	.
122	31	RUBUS IDAEUS	RED RASPBERRY	72	.	1	.	.	.
123	24	LONICERA INVOLUCRATA	TWINBERRY HONEYSUCKLE	70	.	1	.	.	.
124	5	BETULA PAPYRIFERA	PAPER BIRCH	45	1	.	1	.	.
125	99	DECORTICATED TWIGS	DECORTICATED TWIGS	40	1	.	.	.	.
126	347	CORNUS CANADENSIS	BUNCHBERRY	18	.	1	.	.	.
127	98	UNID. PLANT PARTS	UNIDENTIFIED PLANTS	6	.	1	.	.	.
128	1	CORNUS SERICEA	RED-OSIER DOGWOOD	0	.	1	.	.	.
129	2	SALIX SPP	WILLOW	0	.	1	.	.	.
130	5	BETULA PAPYRIFERA	PAPER BIRCH	0	.	1	.	.	.

RUMEN=17 MONYR=184

OBS	SPECIES CODE	BOTANICAL NAME	COMMON NAME	WEIGHT	TWIG	LEAF	BUD	RHIZME	STEM
131	5	BETULA PAPYRIFERA	PAPER BIRCH	158	.	.	.	.	.
132	99	DECORTICATED TWIGS	DECORTICATED TWIGS	92	.	.	.	.	.
133	17	THUJA PLICATA	WESTERN RED CEDAR	47	.	.	.	.	.
134	2	SALIX SPP	WILLOW	33	.	.	.	.	.
135	6	CORYLUS CORNUTA	HAZELNUT	5	.	.	.	.	.
136	7	TAXUS BREVIFOLIA	WESTERN YEW	1	.	.	.	.	.
137	8	PAXISTIMA MYRSINITES	OREGON BOXWOOD	1	.	.	.	.	.

RUMEN CONTENTS GIVING SPECIES, PART EATEN, AND WEIGHT
(FOR PLANT PARTS 1= PRESENT AND .= ABSENT)

RUMEN=18 MONYR=284

OBS	SPECIES CODE	BOTANICAL NAME	COMMON NAME	WEIGHT	TWIG	LEAF	BUD	RHIZME	STEM
138	99	DECORTICATED TWIGS	DECORTICATED TWIGS	359	1	.	.	.	.
139	2	SALIX SPP	WILLOW	222	.	.	.	.	.
140	18	ACER GLABRUM DOUGLASII	DOUGLAS MAPLE	36	.	.	.	.	.
141	6	CORYLUS CORNUTA	HAZELNUT	22	.	.	.	.	.
142	17	THUJA PLICATA	WESTERN RED CEDAR	17	.	.	.	.	.
143	5	BETULA PAPYRIFERA	PAPER BIRCH	7	.	.	.	.	.
144	7	TAXUS BREVIFOLIA	WESTERN YEW	2	.	.	.	.	.
145	25	LONICERA UTAHENSIS	RED TWINBERRY	2	.	.	.	.	.

RUMEN=19 MONYR=284

OBS	SPECIES CODE	BOTANICAL NAME	COMMON NAME	WEIGHT	TWIG	LEAF	BUD	RHIZME	STEM
146	17	THUJA PLICATA	WESTERN RED CEDAR	714	.	.	.	.	.
147	2	SALIX SPP	WILLOW	353	.	.	.	.	.
148	99	DECORTICATED TWIGS	DECORTICATED TWIGS	264	1	.	.	.	.
149	7	TAXUS BREVIFOLIA	WESTERN YEW	132	.	.	.	.	.
150	3	POPULUS BALSAMIFERA TRICH	BLACK COTTONWOOD	92	.	.	.	.	.
151	18	ACER GLABRUM DOUGLASII	DOUGLAS MAPLE	10	.	.	.	.	.
152	8	PAXISTIMA MYRSINITES	OREGON BOXWOOD	6	.	.	.	.	.
153	25	LONICERA UTAHENSIS	RED TWINBERRY	3	.	.	.	.	.
154	53	LOBARIA PULMONARIA	LUNGWORT	2	.	.	.	.	.

RUMEN=20 MONYR=284

OBS	SPECIES CODE	BOTANICAL NAME	COMMON NAME	WEIGHT	TWIG	LEAF	BUD	RHIZME	STEM
155	99	DECORTICATED TWIGS	DECORTICATED TWIGS	344	1	.	.	.	.
156	7	TAXUS BREVIFOLIA	WESTERN YEW	279	1	.	.	.	1
157	8	PAXISTIMA MYRSINITES	OREGON BOXWOOD	101	1	1	.	.	.
158	2	SALIX SPP	WILLOW	33	1	.	.	.	.
159	6	CORYLUS CORNUTA	HAZELNUT	22	1	.	.	1	.
160	17	THUJA PLICATA	WESTERN RED CEDAR	10	1	.	.	.	1
161	53	LOBARIA PULMONARIA	LUNGWORT	10	.	.	.	.	.
162	18	ACER GLABRUM DOUGLASII	DOUGLAS MAPLE	1	1	.	.	.	.

RUMEN CONTENTS GIVING SPECIES, PART EATEN, AND WEIGHT
(FOR PLANT PARTS 1= PRESENT AND .= ABSENT)

RUMEN=21 MONYR=984

OBS	SPECIES CODE	BOTANICAL NAME	COMMON NAME	WEIGHT	TWIG	LEAF	BUD	RHIZME	STEM
163	98	UNID. PLANT PARTS	UNIDENTIFIED PLANTS	111	.	.	.	.	.
164	4	POPULUS TREMULOIDES	TREMBLING ASPEN	65	.	1	.	.	.
165	99	DECORTICATED TWIGS	DECORTICATED TWIGS	37	1	.	.	.	.
166	367	EPILOBIUM ANGUSTIFOLIUM	FIREWEED	34	.	1	.	.	.
167	30	RUBUS PARVIFLORUS	WESTERN THIMBLEBERRY	33	.	.	.	.	.
168	2	SALIX SPP	WILLOW	28	1	.	.	.	.
169	2	SALIX SPP	WILLOW	24	.	1	.	.	.
170	5	BETULA PAPYRIFERA	PAPER BIRCH	17	.	1	.	.	.
171	5	BETULA PAPYRIFERA	PAPER BIRCH	15	1	.	.	.	.
172	8	PAXISTIMA MYRSINITES	OREGON BOXWOOD	8	.	1	.	.	.
173	1	CORNUS SERICEA	RED-OSIER DOGWOOD	6	.	1	.	.	.
174	1	CORNUS SERICEA	RED-OSIER DOGWOOD	6	1	.	.	.	.
175	55	POLYPODIACEAE	FERNS	6	.	1	.	.	.
176	13	VIBURNUM EDULE	HIGH BUSH CRANBERRY	4	.	.	.	.	.
177	7	TAXUS BREVIFOLIA	WESTERN YEW	1	.	.	.	.	.
178	14	ALNUS VIRIDIS SINUATA	SITKA MOUNTAIN ALDER	1	.	.	.	.	.
179	508	VACCINIUM SPP	BLUEBERRIES	1	.	1	.	.	.

RUMEN=22 MONYR=984

OBS	SPECIES CODE	BOTANICAL NAME	COMMON NAME	WEIGHT	TWIG	LEAF	BUD	RHIZME	STEM
180	98	UNID. PLANT PARTS	UNIDENTIFIED PLANTS	1803	.	.	.	.	.
181	10	SORBUS SITCHENSIS	SITKA MOUNTAIN ASH	393	1	1	.	.	.
182	2	SALIX SPP	WILLOW	88	1	1	.	.	.
183	10	SORBUS SITCHENSIS	SITKA MOUNTAIN ASH	81	.	.	.	.	.
184	367	EPILOBIUM ANGUSTIFOLIUM	FIREWEED	54	.	1	.	.	.
185	54	POLYTRICHUM SPP	MOSS	22	1	1	.	.	.
186	26	VACCINIUM MEMBRANACEUM	BLACK BLUEBERRY	19	.	.	.	.	.
187	509	HIERACIUM SPP	HAWKWEED	18	.	1	.	.	.
188	380	ACTAEA RUBRA	BANEBERRY	7	.	1	.	.	.
189	367	EPILOBIUM ANGUSTIFOLIUM	FIREWEED	6	.	.	.	.	.
190	447	TIARELLA UNIFOLIATA	UNIFOL-LVD FOAMFLOWER	6	.	1	.	.	.
191	388	THALICTRUM OCCIDENTALE	WESTERN MEADOW RUE	5	.	1	.	.	.
192	50	RIBES SPP	CURRANT	4	.	1	.	.	.

RUMEN=23 MONYR=984

OBS	SPECIES CODE	BOTANICAL NAME	COMMON NAME	WEIGHT	TWIG	LEAF	BUD	RHIZME	STEM
193	2	SALIX SPP	WILLOW	504	1	1	.	.	.
194	98	UNID. PLANT PARTS	UNIDENTIFIED PLANTS	339	.	1	.	.	.
195	1	CORNUS SERICEA	RED-OSIER DOGWOOD	266	1	1	.	.	.
196	5	BETULA PAPYRIFERA	PAPER BIRCH	97	1	1	.	.	.
197	7	TAXUS BREVIFOLIA	WESTERN YEW	91	1	1	.	.	.
198	30	RUBUS PARVIFLORUS	WESTERN THIMBLEBERRY	63	.	1	.	.	.
199	8	PAXISTIMA MYRSINITES	OREGON BOXWOOD	42	1	1	.	.	.
200	13	VIBURNUM EDULE	HIGH BUSH CRANBERRY	40	1	1	.	.	.

RUMEN CONTENTS GIVING SPECIES, PART EATEN, AND WEIGHT
(FOR PLANT PARTS 1= PRESENT AND .= ABSENT)

RUMEN=23 MONYR=984

OBS	SPECIES CODE	BOTANICAL NAME	COMMON NAME	WEIGHT	TWIG	LEAF	BUD	RHIZME	STEM
201	10	SORBUS SITCHENSIS	SITKA MOUNTAIN ASH	5	.	1	.	.	.
202	510	SYMPHORICARPOS ALBUS	WAXBERRY	3	.	1	.	.	.

RUMEN=24 MONYR=984

OBS	SPECIES CODE	BOTANICAL NAME	COMMON NAME	WEIGHT	TWIG	LEAF	BUD	RHIZME	STEM
203	98	UNID. PLANT PARTS	UNIDENTIFIED PLANTS	252	.	.	.	.	.
204	301	ATHYRIUM FILIX-FEMINA	COMMON LADY FERN	23	.	1	.	.	.
205	8	PAXISTIMA MYRSINITES	OREGON BOXWOOD	22	.	1	.	.	.
206	2	SALIX SPP	WILLOW	7	.	1	.	.	.
207	31	RUBUS IDAEUS	RED RASPBERRY	3	.	1	.	.	.

RUMEN=25 MONYR=1084

OBS	SPECIES CODE	BOTANICAL NAME	COMMON NAME	WEIGHT	TWIG	LEAF	BUD	RHIZME	STEM
208	503	CAREX SPP	SEDGES	898	.	1	.	.	.
209	301	ATHYRIUM FILIX-FEMINA	COMMON LADY FERN	176	.	1	.	.	.
210	99	DECORTICATED TWIGS	DECORTICATED TWIGS	105	1	.	.	.	.
211	5	BETULA PAPYRIFERA	PAPER BIRCH	41	1	.	.	.	.
212	98	UNID. PLANT PARTS	UNIDENTIFIED PLANTS	25	1	.	.	.	1
213	49	OPLOPANAX HORRIDUS	DEVIL'S CLUB	23	.	1	.	.	.
214	303	PTERIDIUM AQUILINUM	WESTERN BRACKEN	23	.	1	.	.	.
215	5	BETULA PAPYRIFERA	PAPER BIRCH	20	.	1	.	.	.
216	18	ACER GLABRUM DOUGLASII	DOUGLAS MAPLE	20	1	.	.	.	.
217	30	RUBUS PARVIFLORUS	WESTERN THIMBLEBERRY	18	.	1	.	.	.
218	45	RHODODENDRON ALBIFLORUM	WH-FLOWERD RHODODENDRON	12	1	.	.	.	.
219	367	EPILOBIUM ANGUSTIFOLIUM	FIREWEED	12	.	1	.	.	.
220	54	POLYTRICHUM SPP	MOSS	11	.	.	.	.	.
221	8	PAXISTIMA MYRSINITES	OREGON BOXWOOD	7	.	1	.	.	.
222	1	CORNUS SERICEA	RED-OSIER DOGWOOD	6	1	.	.	.	.
223	1	CORNUS SERICEA	RED-OSIER DOGWOOD	6	.	1	.	.	.
224	447	TIARELLA UNIFOLIATA	UNIFOL-LVD FOAMFLOWER	6	.	1	.	.	.
225	7	TAXUS BREVIFOLIA	WESTERN YEW	2	1	.	.	.	1
226	312	HERACLEUM SPHONDYLIUM	COMMON COW PARSNIP	2	.	1	.	.	.
227	45	RHODODENDRON ALBIFLORUM	WH-FLOWERD RHODODENDRON	0	.	1	.	.	.

RUMEN CONTENTS GIVING SPECIES, PART EATEN, AND WEIGHT
(FOR PLANT PARTS 1= PRESENT AND .= ABSENT)

RUMEN=26 MONYR=1084

OBS	SPECIES CODE	BOTANICAL NAME	COMMON NAME	WEIGHT	TWIG	LEAF	BUD	RHIZME	STEM
228	99	DECORTICATED TWIGS	DECORTICATED TWIGS	160	.	.	.	.	.
229	1	CORNUS SERICEA	RED-OSIER DOGWOOD	121	1	.	.	.	.
230	2	SALIX SPP	WILLOW	59	1	.	.	.	.
231	2	SALIX SPP	WILLOW	46	.	1	.	.	.
232	1	CORNUS SERICEA	RED-OSIER DOGWOOD	33	.	1	.	.	.
233	7	TAXUS BREVIFOLIA	WESTERN YEW	22	.	.	.	.	.
234	98	UNID. PLANT PARTS	UNIDENTIFIED PLANTS	20	.	.	.	.	.
235	8	PAXISTIMA MYRSINITES	OREGON BOXWOOD	18	.	.	.	.	.
236	5	BETULA PAPYRIFERA	PAPER BIRCH	16	.	1	.	.	.
237	3	POPULUS BALSAMIFERA TRICH	BLACK COTTONWOOD	9	.	.	.	.	.
238	347	CORNUS CANADENSIS	BUNCHBERRY	5	.	1	.	.	.
239	447	TIARELLA UNIFOLIATA	UNIFOL-LVD FOAMFLOWER	2	.	1	.	.	.

RUMEN=27 MONYR=1084

OBS	SPECIES CODE	BOTANICAL NAME	COMMON NAME	WEIGHT	TWIG	LEAF	BUD	RHIZME	STEM
240	7	TAXUS BREVIFOLIA	WESTERN YEW	346	.	.	.	.	.
241	8	PAXISTIMA MYRSINITES	OREGON BOXWOOD	317	1	1	.	.	.
242	435	LYSICHTON AMERICANUM	AMERICAN SKUNK-CABBAGE	221	.	1	.	.	.
243	6	CORYLUS CORNUTA	HAZELNUT	130	1	.	.	.	.
244	1	CORNUS SERICEA	RED-OSIER DOGWOOD	101	1	.	.	.	.
245	6	CORYLUS CORNUTA	HAZELNUT	68	.	.	.	1	.
246	99	DECORTICATED TWIGS	DECORTICATED TWIGS	51	1	.	.	.	.
247	367	EPILOBIUM ANGUSTIFOLIUM	FIREWEED	39	.	1	.	.	.
248	98	UNID. PLANT PARTS	UNIDENTIFIED PLANTS	38	.	1	.	.	.
249	30	RUBUS PARVIFLORUS	WESTERN THIMBLEBERRY	32	.	1	.	.	.
250	2	SALIX SPP	WILLOW	27	1	.	.	.	.
251	3	POPULUS BALSAMIFERA TRICH	BLACK COTTONWOOD	26	1	.	.	.	.
252	2	SALIX SPP	WILLOW	13	.	1	.	.	.
253	49	OPLOPANAX HORRIDUS	DEVIL'S CLUB	11	.	1	.	.	.
254	17	THUJA PLICATA	WESTERN RED CEDAR	6	.	.	.	.	1
255	301	ATHYRIUM FILIX-FEMINA	COMMON LADY FERN	3	.	1	.	.	.
256	26	VACCINIUM MEMBRANACEUM	BLACK BLUEBERRY	1	.	1	.	.	.
257	499	POACEAE	GRASSES	1	.	1	.	.	.

RUMEN=28 MONYR=1184

OBS	SPECIES CODE	BOTANICAL NAME	COMMON NAME	WEIGHT	TWIG	LEAF	BUD	RHIZME	STEM
258	8	PAXISTIMA MYRSINITES	OREGON BOXWOOD	405	1	1	.	.	.
259	5	BETULA PAPYRIFERA	PAPER BIRCH	259	1	.	.	.	.
260	1	CORNUS SERICEA	RED-OSIER DOGWOOD	146	1	.	.	.	.
261	2	SALIX SPP	WILLOW	120	1	.	.	.	.
262	5	BETULA PAPYRIFERA	PAPER BIRCH	104	.	.	.	1	.
263	17	THUJA PLICATA	WESTERN RED CEDAR	86	.	.	.	.	1
264	99	DECORTICATED TWIGS	DECORTICATED TWIGS	85	1	.	.	.	.
265	14	ALNUS VIRIDIS SINUATA	SITKA MOUNTAIN ALDER	40	1	.	.	.	.

RUMEN CONTENTS GIVING SPECIES, PART EATEN, AND WEIGHT
(FOR PLANT PARTS 1= PRESENT AND .= ABSENT)

RUMEN=28 MONYR=1184

OBS	SPECIES CODE	BOTANICAL NAME	COMMON NAME	WEIGHT	TWIG	LEAF	BUD	RHIZME	STEM
266	7	TAXUS BREVIFOLIA	WESTERN YEW	31	1	1	.	.	.
267	6	CORYLUS CORNUTA	HAZELNUT	30	1	.	.	.	.
268	301	ATHYRIUM FILIX-FEMINA	COMMON LADY FERN	15	.	.	.	.	.
269	347	CORNUS CANADENSIS	BUNCHBERRY	0	.	1	.	.	.
270	508	VACCINIUM SPP	BLUEBERRIES	0	1	.	.	.	.

RUMEN=29 MONYR=.

OBS	SPECIES CODE	BOTANICAL NAME	COMMON NAME	WEIGHT	TWIG	LEAF	BUD	RHIZME	STEM
271	8	PAXISTIMA MYRSINITES	OREGON BOXWOOD	969	.	.	.	.	.
272	99	DECORTICATED TWIGS	DECORTICATED TWIGS	486	1	.	.	.	.
273	24	LONICERA INVOLUCRATA	BLACK TWINBERRY	145	.	.	.	.	.
274	435	LYSICHTON AMERICANUM	AMERICAN SKUNK-CABBAGE	58	.	.	.	.	.
275	2	SALIX SPP	WILLOW	45	.	.	.	.	.
276	1	CORNUS SERICEA	RED-OSIER DOGWOOD	41	.	.	.	.	.
277	55	POLYPODIACEAE	FERNS	23	.	.	.	.	.
278	7	TAXUS BREVIFOLIA	WESTERN YEW	4	.	.	.	.	.

RUMEN=30 MONYR=.

OBS	SPECIES CODE	BOTANICAL NAME	COMMON NAME	WEIGHT	TWIG	LEAF	BUD	RHIZME	STEM
279	2	SALIX SPP	WILLOW	291	.	.	.	.	.
280	7	TAXUS BREVIFOLIA	WESTERN YEW	188	.	.	.	.	.
281	99	DECORTICATED TWIGS	DECORTICATED TWIGS	179	1	.	.	.	.
282	18	ACER GLABRUM DOUGLASII	DOUGLAS MAPLE	175	.	.	.	.	.
283	3	POPULUS BALSAMIFERA TRICH	BLACK COTTONWOOD	45	.	.	.	.	.
284	6	CORYLUS CORNUTA	HAZELNUT	9	.	.	.	.	.
285	17	THUJA PLICATA	WESTERN RED CEDAR	2	.	.	.	.	.

RUMEN=31 MONYR=.

OBS	SPECIES CODE	BOTANICAL NAME	COMMON NAME	WEIGHT	TWIG	LEAF	BUD	RHIZME	STEM
286	99	DECORTICATED TWIGS	DECORTICATED TWIGS	551	.	.	.	.	.
287	1	CORNUS SERICEA	RED-OSIER DOGWOOD	313	.	.	.	.	.
288	7	TAXUS BREVIFOLIA	WESTERN YEW	239	.	.	.	.	.
289	2	SALIX SPP	WILLOW	108	.	.	.	.	.
290	3	POPULUS BALSAMIFERA TRICH	BLACK COTTONWOOD	53	.	.	.	.	.
291	17	THUJA PLICATA	WESTERN RED CEDAR	53	.	.	.	.	.
292	6	CORYLUS CORNUTA	HAZELNUT	15	.	.	.	.	.
293	15	ALNUS ICANA TENUIFOLIA	THIN-LEAVED MTN ALDER	10	.	.	.	.	.

RUMEN CONTENTS GIVING SPECIES, PART EATEN, AND WEIGHT
(FOR PLANT PARTS 1= PRESENT AND .= ABSENT)

RUMEN=32 MONYR=.

OBS	SPECIES CODE	BOTANICAL NAME	COMMON NAME	WEIGHT	TWIG	LEAF	BUD	RHIZME	STEM
294	2	SALIX SPP	WILLOW	252	.	.	.	.	.
295	99	DECORTICATED TWIGS	DECORTICATED TWIGS	205	1	.	.	.	.
296	17	THUJA PLICATA	WESTERN RED CEDAR	171	.	.	.	.	.
297	5	BETULA PAPYRIFERA	PAPER BIRCH	15	.	.	.	.	.
298	1	CORNUS SERICEA	RED-OSIER DOGWOOD	7	.	.	.	.	.
299	18	ACER GLABRUM DOUGLASII	DOUGLAS MAPLE	0	.	.	.	.	.
300	25	LONICERA UTAHENSIS	RED TWINBERRY	0	.	.	.	.	.